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ANNALS of the
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GEOGRAPHY, EXPERIENCE, AND IMAGINATION: TOWARDS A GEOGRAPHICAL EPISTEMOLOGY[1]

DAVID LOWENTHAL

American Geographical Society, New York

"THE most fascinating *terrae incognitae* of all are those that lie within the minds and hearts of men." With these words, John K. Wright concluded his 1946 presidential address before the Association of American Geographers. This paper considers the nature of these *terrae incognitae*, and the relation between the world outside and the pictures in our heads.[2]

THE GENERAL AND THE GEOGRAPHICAL WORLD VIEW

Neither the world nor our pictures of it are identical with geography. Some aspects of geography are recondite, others abstruse, occult, or esoteric; conversely, there are many familiar features of things that geography scarcely considers. Beyond that of any other discipline, however, the subject matter of geography approximates the world of general discourse; the palpable present, the everyday life of man on earth, is seldom far from our professional concerns. "There is no science whatever," wrote a future president of Harvard, a century and a half ago, "which comes so often into use in common life."[3] This view of geography remains a commonplace of contemporary thought. More than physics or physiology, psychology or politics, geography observes and analyzes aspects of the milieu on the scale and in the categories that they are usually apprehended in everyday life. Whatever methodologists think geography ought to be, the temperament of its practition-

[1] This is an expanded version of a paper read at the XIXth International Geographical Congress, Stockholm, August, 1960. For encouragement, advice, and criticism, I am grateful to George A. Cooper, Richard Hartshorne, William C. Lewis, William D. Pattison, Michael G. Smith, Philip L. Wagner, William Warntz, J. W. N. Watson, and John K. Wright. Richard F. Kuhns, Jr., has kindly read and commented on several drafts of the manuscript, and I am indebted to him for numerous suggestions and references.

[2] John K. Wright, "Terrae Incognitae: the Place of the Imagination in Geography," *Annals*, Association of American Geographers, Vol. 37 (1947), pp. 1–15, on p. 15. The phrase "The World Outside and the Pictures in Our Heads" is the name of the first chapter in Walter Lippmann, *Public Opinion* (New York: Macmillan, 1922). As my subtitle suggests, this is not a study of the meaning or methods of geography, but rather an essay in the theory of geographical knowledge. Hartshorne's methodological treatises analyze and develop logical principles of procedure for geography as a professional science, "a form of 'knowing,'" as he writes, "that is different from the ways in which we 'know' by instinct, intuition, *a priori* deduction or revelation" (Richard Hartshorne, *Perspective on the Nature of Geography* [Chicago: Rand McNally, for Association of American Geographers, 1959], p. 170). My epistemological inquiry, on the other hand, is concerned with *all* geographical thought, scientific and other: how it is acquired, transmitted, altered, and integrated into conceptual systems; and how the horizon of geography varies among individuals and groups. Specifically, it is a study in what Wright calls *geosophy*: "the nature and expression of geographical ideas both past and present . . . the geographical ideas, both true and false, of all manner of people—not only geographers, but farmers and fishermen, business executives and poets, novelists and painters, Bedouins and Hottentots" ("Terrae Incognitae," p. 12). Because geographers are "nowhere . . . more likely to be influenced by the subjective than in their discussions of what scientific geography ought to be" (*ibid.*), epistemology helps to explain why and how methodologies change.

[3] Jared Sparks, MS. in Sparks Collection (132, Misc. Papers, Vol. I, 1808–14), Harvard College Library; quoted in Ralph H. Brown, "A Plea for Geography, 1813 Style," *Annals*, Association of American Geographers, Vol. 41 (1951), p. 235. For similar nineteenth-century views see my "George Perkins Marsh on the Nature and Purpose of Geography," *Geographical Journal*, Vol. 126 (1960), pp. 413–17.

ers makes it catholic and many-sided. In their range of interests and capacities—concrete and abstract, academic and practical, analytic and synthetic, indoor and outdoor, historical and contemporary, physical and social—geographers reflect man generally. "This treating of cabbages and kings, cathedrals and linguistics, trade in oil, or commerce in ideas," as Peattie wrote, "makes a congress of geographers more or less a Committee on the Universe."[4]

Geographical curiosity is, to be sure, more narrowly focused than mankind's; it is also more conscious, orderly, objective, consistent, universal, and theoretical than are ordinary queries about the nature of things. Like geography, however, the wider universe of discourse centers on knowledge and ideas about man and milieu; anyone who inspects the world around him is in some measure a geographer.

As with specifically geographical concepts, the more comprehensive world of ideas that we share concerns the variable forms and contents of the earth's surface, past, present, and potential—"a torrent of discourse about tables, people, molecules, light rays, retinas, air-waves, prime numbers, infinite classes, joy and sorrow, good and evil."[5] It comprises truth and error, concrete facts and abstruse relationships, self-evident laws and tenuous hypotheses, data drawn from natural and social science, from history, from common sense, from intuition and mystical experience. Certain things appear to be grouped spatially, seriated temporally, or related causally: the hierarchy of urban places, the annual march of temperature, the location of industry. Other features of our shared universe seem unique, amorphous, or chaotic: the population of a country, the precise character of a region, the shape of a mountain.[6]

Universally Accepted Aspects of the World View

However multifarious its makeup, there is general agreement about the character of the world and the way it is ordered. Explanations of particular phenomena differ from one person to another, but without basic concurrence as to the nature of things, there would be neither science nor common sense, agreement nor argument. The most extreme heretic cannot reject the essence of the prevailing view. "Even the sharpest dissent still operates by partial submission to an existing consensus," reasons

[4] Roderick Peattie, *Geography in Human Destiny* (New York: George W. Stewart, 1940), pp. 26–27. "In the broadest sense," Richard Hartshorne notes, "all facts of the earth surface are geographical facts" (*The Nature of Geography: a Critical Survey of Current Thought in the Light of the Past* [Lancaster, Pa.: Association of American Geographers, 1939], p. 372). On the interests and capacities of geographers, see J. Russell Whitaker, "The Way Lies Open," *Annals*, Association of American Geographers, Vol. 44 (1954), p. 242; and André Meynier, "Réflexions sur la spécialisation chez les Géographes," *Norois*, Vol. 7 (1960), pp. 5–12.

Most of the physical and social sciences are, both in theory and in practice, more generalizing and formalistic than geography. The exceptions are disciplines which, like geography, are in some measure humanistic: notably anthropology and history. The subject-matter of anthropology is as diversified as that of geography, and more closely mirrors the everyday concerns of man; but anthropological research still concentrates predominantly on that small and remote fraction of mankind—"primitive" or nonliterate, traditional in culture, homogeneous in social organization—whose ways of life and world views are least like our own (Ronald M. Berndt, "The Study of Man: an Appraisal of the Relationship between Social and Cultural Anthropology and Sociology," *Oceania*, Vol. 31 [1960], pp. 85–99). More particularistic, more concerned with uniqueness of context than geography, history also comprehends more matters of common interest (especially the acts and feelings of individuals); but because the whole realm of history lies in the past, most historical data is secondary, derivative. Although "geography cannot be strictly contemporary" (Preston E. James, "Introduction: the Field of Geography," in *American Geography: Inventory and Prospect* [Syracuse University Press, for Association of American Geographers, 1954], p. 14), geography is usually *focused* on the present; direct observation of the world plays a major role in geography, a trifling one in history. In theory, at least, the remote in space is everywhere (on the face of the earth) personally accessible to us, the remote in time accessible only through memories and artifacts.

[5] W. V. Quine, "The Scope and Language of Science," *British Journal for the Philosophy of Science*, Vol. 8 (1957), pp. 1–17, on p. 1.

[6] For various combinations of geographical facts and relationships, see John K. Wright, "'Crossbreeding' Geographical Quantities," *Geographical Review*, Vol. 45 (1955), pp. 52–65. For the varieties of data that comprise knowledge in general, see Rudolph Carnap, "Formal and Factual Science," in Herbert Feigl and May Brodbeck, eds., *Readings in the Philosophy of Science* (New York: Appleton-Century-Crofts, 1953), pp. 123–128; Karl R. Popper, *The Logic of Scientific Discovery* (New York: Basic Books, 1959), appendix x, pp. 420–441: Friedrich Waismann, "Analytic-Synthetic," *Analysis*, Vol. 11 (1950–51), pp. 52–56; J. W. N. Watkins, "Between Analytic and Empirical," *Philosophy*, Vol. 32 (1957), pp. 112–131.

Polanyi, "for the revolutionary must speak in terms that people can understand."[7]

Most public knowledge can in theory be verified. I know little about the geography of Sweden, but others are better informed; if I studied long and hard enough I could learn approximately what they know. I cannot read the characters in Chinese newspapers, but hardly doubt that they convey information to the Chinese; assuming that there is a world in common, other peoples' ways of symbolizing knowledge must be meaningful and learnable.

The universe of geographical discourse, in particular, is not confined to geographers; it is shared by billions of amateurs all over the globe. Some isolated primitives are still ignorant of the outside world; many more know little beyond their own countries and ways of life; but most of the earth's inhabitants possess at least rudiments of the shared world picture. Even peoples innocent of science are privy to elements of our geography, both innate and learned: the normal relations between figure and ground; the distinctive setting of objects on the face of the earth; the usual texture, weight, appearance, and physical state of land, air, and water; the regular transition from day to night; the partition of areas by individual, family, or group.

Beyond such universals, the geographical consensus tends to be additive, scientific, and cumulative. Schools teach increasing numbers that the world is a sphere with certain continents, oceans, countries, peoples, and ways of living and making a living; the size, shape, and general features of the earth are known by more and more people. The general horizon of geography has expanded rapidly. "Until five centuries ago a primal or regional sense of space dominated human settlements everywhere"; today, most of us share the conception of a world common to all experients.[8]

The General Consensus Never Completely Accepted

The whole of mankind may in time progress, as Whittlesey suggests, to "the sense of space current at or near the most advanced frontier of thought." But no one, however inclined to pioneer, visits that frontier often, or has surveyed more than a short traverse of it. "Primitive man," according to Boulding, "lives in a world which has a spatial unknown, a dread frontier populated by the heated imagination. For modern man the world is a closed and completely explored surface. This is a radical change in spatial viewpoint."[9] But the innovation is superficial; we are still parochial. "Even in lands where geography is part of a compulsory school curriculum, and among people who possess considerable information about the earth," Whittlesey points out, "the world horizon is accepted in theory and rejected in practice."[10]

The "dread unknowns" are still with us. Indeed, "the more the island of knowledge expands in the sea of ignorance, the larger its boundary to the unknown."[11] Primitive world views were simple and consistent enough for every participant to share most of their substance. Within Western scientific society, no one really grasps more than a small fraction of the public, theoretically communicable world view. The amount of information an individual can acquire in an instant or in a lifetime is finite, and miniscule compared with what the milieu presents; many questions are too complex to describe, let alone solve, in a practicable length of time. The horizons of knowledge are expanding faster than any person can keep up with. The proliferation of new sciences extends our powers of sense and thought, but their rigorous techniques and technical languages hamper communication; the common field of knowledge becomes a diminishing fraction of the total store.[12]

[7] Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago: University of Chicago Press, 1958), pp. 208–209.

[8] Derwent Whittlesey, "The Horizon of Geography," *Annals*, Association of American Geographers, Vol. 35 (1945), pp. 1–36, on p. 14.

[9] Kenneth E. Boulding, *The Image* (Ann Arbor: University of Michigan Press, 1956), p. 66.

[10] Whittlesey, *op. cit.*, pp. 2, 14.

[11] L. S. Rodberg and V. F. Weisskopf, "Fall of Parity," *Science*, Vol. 125 (1957), pp. 627–33; on p. 632.

[12] Polanyi, *Personal Knowledge*, p. 216; Rafael Rodriguez Delgado, "A Possible Model for Ideas," *Philosophy of Science*, Vol. 24 (1957), pp. 253–269, on p. 255. "The organism has a definite capacity for information which is a minute fraction of the physical signals that reach the eyes, ears, and epidermis" (Colin Cherry, *On Human Communication: a Review, a Survey, and a Criticism* [New York: Wiley, 1957], p. 284). See also George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review*, Vol. 63 (1956), pp. 81–97; Henry Quastler, "Studies of Human Channel Capacity," in Colin Cherry, ed., *Information Theory; Papers Read at the Third London Symposium, 1955* (New York: Academic Press, 1956), pp. 361–371.

On the other hand, we tend to assume things are common knowledge which may not be; what seems to me the general outlook might be mine alone. The most devoted adherents to a consensus often mistake their own beliefs for universal ones. For a large part of our world view, we take on faith much of what we are told by science. But we may have got it wrong; as Chisholm points out, "we are all quite capable of believing falsely at any time that a given proposition is accepted by the scientists of our culture circle."[13] In our impressions of the shared world view we all resemble the fond mother who watched her clumsy son parade, and concluded happily, "Everyone was out of step but my Johnnie."

The World View Not Shared by Some

The most fundamental attributes of our shared view of the world are confined, moreover, to sane, hale, sentient adults. Idiots cannot suitably conceive space, time, or causality. Psychotics distinguish poorly between themselves and the outside world. Mystics, claustrophobics, and those haunted by fear of open space (agoraphobia) tend to project their own body spaces as extensions of the outside world; they are often unable to delimit themselves from the rest of nature. Schizophrenics often underestimate size and overestimate distance. After a brain injury, invalids fail to organize their environments or may forget familiar locations and symbols. Impairments like aphasia, apraxia, and agnosia blind their victims to spatial relations and logical connections self-evident to most. Other hallucinatory sufferers may identify forms but regularly alter the number, size, and shape of objects (polyopia, dysmegalopsia, dysmorphopsia), see them always in motion (oscillopsia), or locate everything at the same indefinite distance (porrhopsia).[14]

A fair measure of sensate function is also prerequisite to the general view of the common world. No object looks quite the way it feels; at first sight, those born blind not only fail to recognize visual shapes but see no forms at all, save for a spinning mass of colored light. They may have known objects by touch, but had nothing like the common conception of a space with objects in it. A purely visual world would also be an unreal abstraction; a concrete and stable sense of the milieu depends on synesthesia, sight combined with sound and touch.[15]

To see the world more or less as others see it, one must above all grow up; the very young, like the very ill, are unable to discern adequately what is themselves and what is not. An infant is not only the center of his universe, he *is* the universe. To the young child, everything in the world is alive, created by and for man, and endowed with will: the sun follows him, his parents built the mountains, trees exist because they were planted. As Piaget puts it, everything seems intentional; "the child behaves as if nature were charged with purpose," and

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[13] Roderick M. Chisholm, *Perceiving: a Philosophical Study* (Ithaca: Cornell University Press, 1957), p. 36. Personal surprise and disappointment are evidence to most of us that our private worlds are not, in fact, identical with the common world view (R. E. Money-Kyrle, "The World of the Unconscious and the World of Commonsense," *British Journal for the Philosophy of Science*, Vol. 7 [1956], pp. 86–96, on p. 93). G. A. Birks, "Towards a Science of Social Relations," (*ibid.*, Vol. 7 [1956], pp. 117–128, 206–221) shows what happens when private ideas about the world have to be adjusted to conform with the consensus.

[14] For the effects of various types of illness and injury on perception and cognition of the milieu see Otto Fenichel, *The Psychoanalytic Theory of Neurosis* (New York: W. W. Norton, 1945), p. 204; C. O. de la Garza and Philip Worchel, "Time and Space Orientation in Schizophrenics," *Journal of Abnormal and Social Psychology*, Vol. 52 (1956), pp. 191–194; T. E. Weckowicz and D. B. Blewett, "Size Constancy and Abstract Thinking in Schizophrenia," *Journal of Mental Science*, Vol. 105 (1959), pp. 909–934; H. J. Eysenck, G. W. Granger, and J. C. Brengelmann, *Perceptual Processes and Mental Illness*, Institute of Psychiatry, Maudsley Monographs No. 2 (London: Chapman and Hall, 1957); G. W. Granger, "Psychophysiology of Vision," in *International Review of Neurobiology*, Vol. 1 (1959) [New York: Academic Press], pp. 245–298; Andrew Paterson and O. L. Zangwill, "A Case of Topographic Disorientation Associated with a Unilateral Cerebral Lesion," *Brain*, Vol. 68 (1945), pp. 188–212; A. R. Luria, "Disorders of 'Simultaneous Perception' in a Case of Bilateral Occipito-Parietal Brain Injury," *Brain*, Vol. 82 (1959), pp. 437–49.

[15] "From a perception of only 3 senses . . . none could deduce a fourth or fifth" (William Blake, "There Is No Natural Religion: First Series," in *Selected Poetry and Prose of William Blake* [New York: Modern Library, 1953], p. 99); the congenital deaf-mute does not know how music sounds even though he knows that tones exist. For the effects of sensory deprivation, see Felix Deutsch, "The Sense of Reality in Persons Born Blind," *Journal of Psychology*, Vol. 10 (1940), pp. 121–140; Kai von Fieandt, "Toward a Unitary Theory of Perception," *Psychological Review*, Vol. 65 (1958), pp. 315–20; Géza Révész, *Psychology and Art of the Blind* (London: Longmans, Green, 1950); J. Z. Young, *Doubt and Certainty in Science: a Biologist's Reflection on the Brain* (Oxford: Clarendon Press, 1951), pp. 61–66.

therefore conscious. The clouds know what they are doing, because they have a goal. "It is not because the child believes things to be alive that he regarded them as obedient, but it is because he believes them to be obedient that he regards them as alive." Asked what something is, the young child often says it is *for* something—"a mountain is for climbing"—which implies that it has been *made* for that purpose.[16]

Unable to organize objects in space, to envisage places out of sight, or to generalize from perceptual experience, young children are especially poor geographers. To learn that there are other people, who perceive the world from different points of view, and that a stable, communicable view of things cannot be obtained from one perspective alone, takes many years. Animism and artificialism give way only gradually to mechanistic outlooks and explanations. "No direct experience can prove to a mind inclined towards animism that the sun and the clouds are neither alive nor conscious"; the child must first realize that his parents are not all-powerful beings who made a universe centered on himself. Piaget traces the development in children of perceptual and conceptual objectivity, on which even the most primitive and parochial geographies depend.[17] Again in old age, however, progressive loss of hearing, deficiencies of vision, and other infirmities tend to isolate one from reality and to create literally a second geographical childhood.[18]

Different as they are from our own, the perceived milieus, say, of most children of the same age (or of many schizophrenics; or of some drug addicts) may closely resemble one another. But there is little communication or mutual understanding of a conceptual character among children. No matter how many features their pictures of the world may have in common, they lack any *shared* view of the nature of things.

Mutability of the General Consensus

The shared world view is also transient: it is neither the world our parents knew nor the one our children will know. Not only is the earth itself in constant flux, but every generation finds new facts and invents new concepts to deal with them. "You cannot step twice into the same river," Heraclitus observed, "for fresh waters are ever flowing in upon you." Nor does anyone look at the river again in the same way: "The vision of the world geographers construct must be created anew each generation, not only because reality changes but also because human preoccupations vary."[19]

Because we cherish the past as a collective guide to behavior, the general consensus alters very slowly. Scientists as well as laymen ignore evidence incompatible with their preconceptions. New theories which fail to fit established views are resisted, in the hope that they will

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[16] Jean Piaget, *The Child's Conception of the World* (Paterson, N. J.: Littlefield and Adams, 1960), pp. 248, 357.

[17] *Child's Conception of the World*, pp. 384–385; *Construction of Reality in the Child* (New York: Basic Books, 1954), pp. 367–369. Piaget and his associates have worked chiefly with schoolchildren in Geneva. How far their categories and explanations apply universally or vary with culture and milieu remains to be determined. Margaret Mead ("An Investigation of the Thought of Primitive Children, with Special Reference to Animism," *Journal of the Anthropological Institute*, Vol. 62 [1932], pp. 173–190) found that Manus children rejected animistic explanations of natural phenomena. They were more matter-of-fact than Swiss children (and Manus adults) because their language was devoid of figures of speech, because they were punished when they failed to cope effectively with the environment, because their society possessed no machines too complex for children to understand, and because they were barred from animistic rites until past puberty. In Western society, on the other hand, "the language is richly animistic, children are given no such stern schooling in physical adjustment to a comprehensible and easily manipulated physical environment, and the traditional animistic material which is decried by modern scientific thinking is still regarded as appropriate material for child training" (p. 189). (Indeed, books written for children show clearly that adults think children *ought* to be animists.) Elsewhere, however, child animism appears to be significant and tends to decline with age and maturity (Gustav Jahoda, "Child Animism: I. A Critical Survey of Cross-Cultural Research," *Journal of Social Psychology*, Vol. 47 [1958], pp. 197–212).

[18] The decline of sensory perception leads the elderly to make false judgments about the environment, and often arouses feelings of isolation and apathy. See Alfred D. Weiss, "Sensory Functions," and Harry W. Braun, "Perceptual Processes," in J. E. Birren, ed., *Handbook of Aging and the Individual: Psychological and Biological Aspects* (Chicago: Univeristy of Chicago Press, 1959), pp. 503–542 and 543–561, respectively.

[19] Marcel Bélanger, "J'ai choisi de devenir géographe," *Revue Canadienne de Géographie*, Vol. 13 (1959), pp. 70–72, on p. 70. This version of Heraclitus is in Bertrand Russell, *A History of Western Philosophy* (New York: Simon and Schuster, 1945), p. 45; a somewhat different phrasing appears in Plato's "Cratylus" (*The Dialogues of Plato*, B. Jowett, tr., 2 vols. [New York: Random House, 1937], Vol. 1, p. 191).

prove false or irrelevant; old ones yield to convenience rather than to evidence. In Eiseley's phrase, "a world view does not dissolve overnight. Rather, like . . . mountain ranges, it erodes through long centuries."[20] The solvent need not be truth. For example, in the seventeenth century many scholars believed that the earth—the "Mundane Egg"—was originally "smooth, regular, and uniform; without Mountains, and without a Sea"; to chastise man for his sins, at or before the Deluge, God crumpled this fair landscape into continents and ocean deeps, with unsightly crags and chasms; modern man thus looked out on "the Ruins of a broken World." This version of earth history was overthrown, not by geological evidence, but principally by a more sanguine view of God and man, and by a new esthetic standard: to eighteenth century observers, mountains seemed majestic and sublime, rather than hideous and corrupt.[21]

Anthropocentric Character of the World View

Mankind's best conceivable world view is at most a partial picture of the world—a picture centered on man. We inevitably see the universe from a human point of view and communicate in terms shaped by the exigencies of human life. " 'Significance' in geography is measured, consciously or unconsciously," says Hartshorne, "in terms of significance to man"; but it is not in geography alone that man is the measure. "Our choice of time scale for climatology," according to Hare, "is conditioned more by the length of our life span than by logic"; the physics of the grasshopper, Köhler points out, would be a different physics than ours.[22] "All aspects of the environment," as Cantril puts it, "exist for us only in so far as they are related to our purposes. If you leave out human significance, you leave out all constancy, all repeatability, all form."[23]

Purpose apart, physical and biological circumstances restrict human perception. Our native range of sensation is limited; other creatures experience other worlds than ours. The human visual world is richly differentiated, compared with that of most species, but others see better in the dark, perceive ultraviolet rays as colors, distinguish finer detail, or see near and distant scenes together in better focus. To many creatures the milieu is more audible and more fragrant than to us. For every sensation, moreover, the human perceptual world varies within strict limits; how bright the lightning looks, how loud the thunder sounds, how wet the rain feels at any given moment of a storm depends on fixed formulae, whose constants, at least, are unique to man.[24]

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[20] Loren Eiseley, *The Firmament of Time* (New York: Atheneum, 1960), p. 38. Scientists at the French Academy in the seventeenth century denied evidence for the fall of meteorites, obvious to most observers, because they opposed the prevalent superstition that meteorites came by supernatural means. For this and other instances of how "the most stubborn facts will be set aside if there is no place for them in the established framework of science," see Polanyi, *Personal Knowledge*, pp. 138–158.

[21] Marjorie Hope Nicolson, *Mountain Gloom and Mountain Glory: The Development of the Aesthetics of the Infinite* (Ithaca: Cornell University Press, 1959); quotations (from Thomas Burnet's *Sacred Theory of the Earth* [London, 1684]) on pp. 198, 206.

[22] Hartshorne, *Perspective on the Nature of Geography*, p. 46; F. Kenneth Hare, "The Westerlies," *Geographical Review*, Vol. 50 (1960), p. 367; Wolfgang Köhler, *The Place of Value in a World of Facts* ([1938 ed.] New York: Meridian Books, 1959). "There is no ultimate source for the physicist's concepts," adds Köhler, "other than the phenomenal world" (p. 374).

[23] Hadley Cantril, "Concerning the Nature of Perception," *Proceedings of the American Philosophical Society*, Vol. 104 (1960), pp. 467–473, on p. 470. "The environment with which we are concerned is not the one which is measured in microns, nor that which is measured in light years, but that which is measured in millimeters or meters . . . [It] is not that of particles, atoms, molecules, or anything smaller than crystals. Nor is it that of planets, stars, galaxies, or nebulae. The world of man . . . consists of matter in the solid, liquid, or gaseous state, organized as an array of surfaces or interfaces between matter in these different states" (James J. Gibson, "Perception as a Function of Stimulation," in Sigmund Koch, ed., *Psychology: a Study of a Science, Study I. Conceptual and Systematic: Vol. I. Sensory, Perceptual, and Physiological Foundations* [New York: McGraw-Hill, 1959], pp. 456–501, on p. 469).

[24] S. S. Stevens, "To Honor Fechner and Repeal His Law," *Science*, Vol. 133 (1961), pp. 80–86. For human and animal sensory and perceptual capacities see Adolf Portmann, "The Seeing Eye," *Landscape*, Vol. 9 (1959), pp. 14–18; Ernest Baumgardt, "La vision des insectes," *La Nature*, Vol. 90 (1960), pp. 96–99; Donald R. Griffin, "Sensory Physiology and the Orientation of Animals," *American Scientist*, Vol. 41 (1953), pp. 208–44; M. J. Wells, "What the Octopus Makes of It: Our World from Another Point of View," *Advancement of Science*, Vol. 17 (1961), pp. 461–471; J. von Uexküll, *Umwelt und Innenwelt der Tiere* (Berlin: Julius Springer, 1909); Karl von Frisch, *Bees: their Vision, Chemical Senses, and Language* (Ithaca: Cornell University Press, 1950), pp. 8–12, 34–36; Donald R. Griffin, *Listening in the Dark: the Acoustic Orientation of Bats and Men* (New Haven: Yale University Press, 1958); K. von Frisch, "Über den Farbsinn der Insek-

The instruments of science do permit partial knowledge of other milieus, real or hypothetical. Blood ordinarily appears a uniform, homogeneous red to the naked eye; seen through a microscope, it becomes yellow particles in a neutral fluid, while its atomic substructure is mostly empty space. But such insights do not show what it is actually like to see normally at a microscopic scale. "The apparently standardized environment of flour in a bottle," Anderson surmises, "would not seem undifferentiated to any investigator who had once been a flour beetle and who knew at firsthand the complexities of flour-beetle existence."[25] The perceptual powers and central nervous systems of many species are qualitatively, as well as quantitatively, different from man's. We can observe, but never experience, the role of surface tension and molecular forces in the lives of small invertebrates, the ability of the octopus to discriminate tactile impressions by taste, of the butterfly to sense forms through smell, or of the jellyfish to change its size and shape.

The tempo of all varieties of experience is also specific. Time yields humans on the average eighteen separate impressions, or instants, every second; images presented more rapidly seem to fuse into continuous motion. But there are slow-motion fish that perceive separate impressions up to thirty each second, and snails to which a stick that vibrates more than four times a second appears to be at rest.[26]

As with time, so with space; we perceive one of many possible structures, more hyperbolic than Euclidean.[27] The six cardinal directions are not equivalent for us: up and down, front and back, left and right have particular values because we happen to be a special kind of bilaterally symmetrical, terrestrial animal. "It is one contingent fact about the world that we attach very great importance to things having their tops and bottoms in the right places; it is another contingent fact [about ourselves] that we attach more importance to their having their fronts and backs in the right places than their left and right sides."[28] Up and down are everywhere good and evil: heaven and hell, the higher and lower instincts, the heights of sublimity and the depths of degradation, even the higher and the lower latitudes have ethical spatial connotations. And left and right are scarcely less differentiated.

Other species apperceive quite differently. Even the fact that physical space seems to us three-dimensional is partly contingent on our size, on the shape of our bodies (an asymmetrical torus), and, perhaps, on our semicircular canals; the world of certain birds is effectively two-dimensional, and some creatures apprehend only one.[29]

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ten," and G. Viaud, "La Vision chromatique chez les animaux (sauf les insectes)," in *Mechanisms of Colour Discrimination* (New York: Pergamon Press, 1960), pp. 19–40 and 41–66, respectively; Conrad G. Mueller, "Visual Sensitivity," Irwin Pollack, "Hearing," and Lloyd M. Beidler, "Chemical Senses," in *Annual Review of Psychology*, Vol. 12 (1961), pp. 311–334, 335–362, and 363–388, respectively.

[25] Edgar Anderson, "Man as a Maker of New Plants and New Plant Communities," in William L. Thomas, Jr., ed., *Man's Role in Changing the Face of the Earth* (Chicago: University of Chicago Press, 1956), pp. 763–777, on p. 776.

[26] J. von Uexküll, *Theoretical Biology* (London: Kegan Paul, 1926), pp. 66–68; Ludwig von Bertalanffy, "An Essay on the Relativity of Categories," *Philosophy of Science*, Vol. 22 (1955), pp. 243–263, on p. 249.

[27] Visual space is Euclidean only locally; for normal observers with binocular vision, space has a constant negative curvature corresponding with the hyperbolic geometry of Lobachevski. See Rudolph K. Luneburg, *Mathematical Analysis of Binocular Vision* (Princeton: Princeton University Press, 1947), and Albert A. Blank, "Axiomatics of Binocular Vision. The Foundations of Metric Geometry in Relation to Space Perception," *Journal of the Optical Society of America*, Vol. 48 (1958), pp. 328–334. But under optimal conditions, Gibson maintains, perceptual space is Euclidean ("Perception as a Function of Stimulation," pp. 479–480).

[28] Bernard Mayo, "The Incongruity of Counterparts," *Philosophy of Science*, Vol. 25 (1958), pp. 109–115, on p. 115; Martti Takala, *Asymmetries of Visual Space* [*Annales Academie Scientarium Fennicae*, Ser. B., Vol. 72, No. 2] (Helsinki, 1951). Because gravity, unlike bilateral symmetry, affects everything on earth, people adapt more rapidly to distorting spectacles that invert up and down than to those that reverse left and right (Julian E. Hochberg, "Effects of the Gestalt Revolution: the Cornell Symposium on Perception," *Psychological Review*, Vol. 64 [1957], pp. 74–76).

[29] G. J. Whitrow, "Why Physical Space Has Three Dimensions," *British Journal for the Philosophy of Science*, Vol. 6 (1955), pp. 13–31; I. J. Good, "Lattice Structure of Space-Time," *ibid.*, Vol. 9 (1959), pp. 317–319. On righteousness as a function of height, see Geraldine Pederson-Krag, "The Use of Metaphor In Analytic Thinking," *Psychoanalytic Quarterly*, Vol. 25 (1956), p. 70. Of the opposition of right and left, Robert Hertz remarks, "if organic asymmetry had not existed, it would have had to be invented" (*Death and the Right Hand* [Glencoe, Ill.: Free Press, 1960], p. 98), and Rodney Needham concludes that "in every quarter of the world it is the right hand, and not the left, which is predominant" ("The Left Hand of the Mugwe: an Analytic Note on the Structure of Meru Symbolism," *Africa*, Vol. 30 [1960], p. 20).

Man's experienced world is, then, only one tree of the forest. The difference between this and the others is that man knows his tree is not the only one; and yet can imagine what the forest as a whole might be like. Technology and memory extend our images far beyond the bounds of direct sensation; consciousness of self, of time, of relationship, and of causality overcome the separateness of individual experiences.[30] Thanks to what has been likened to "a consummate piece of combinatorial mathematics,"[31] we share the conception of a common world. Whatever the defects of the general consensus, the shared world view is essentially well-founded. "We are quite willing to admit that there may be errors of detail in this knowledge," as Russell wrote, referring to science, "but we believe them to be discoverable and corrigible by the methods which have given rise to our beliefs, and we do not, as practical men, entertain for a moment the hypothesis that the whole edifice may be built on insecure foundations."[32]

PERSONAL GEOGRAPHIES

Separate personal worlds of experience, learning, and imagination necessarily underlie any universe of discourse. The whole structure of the shared picture of the world is relevant to the life of every participant; and anyone who adheres to a consensus must personally have acquired some of its contituent elements. As Russell put it, "If I believe that there is such a place as Semipalatinsk, I believe it because of things that have happened to *me*."[33] One need not have been in Semipalatinsk; it is enough to have heard of it in some meaningful connection, or even to have imagined (rightly or wrongly) that it exists, on the basis of linguistic or other evidence. But if the place did not exist in some —and potentially in all—personal geographies, it could scarcely form part of a common world view.

Individual and Consensual Worlds Compared

The personal *terra cognita* is, however, in many ways unlike the shared realm of knowledge. It is far more localized and restricted in space and time: I know nothing about the microgeography of most of the earth's crust, much less than the sum of common knowledge about the world as a whole and larger parts, but a great deal about that tiny fraction of the globe I live in—not merely facts that might be inferred from general knowledge and verified by visitors, but aspects of things that no one, lacking my total experience, could ever grasp as I do. "The entire earth," as Wright says, is thus "an immense patchwork of miniature *terrae incognitae*"[34]—parts of private worlds not incorporated into the general image. Territorially, as otherwise, each personal environment is both more and less inclusive than the common realm.

Complex Nature of Personal Milieus

The private milieu is more complex and many aspects of it are less accessible to inquiry and

[30] "Il y a une différence fondamentale dans la 'facon d'être-au-monde' de l'homme et de l'animal supérieur: ce fait d'être comme englué dans l'objet, de ne pouvoir le survoler, dû . . . à l'unité que fait l'animal avec le monde . . . . L'animal ne peut transcender le réel immédiat" (Jean-C. Filloux, "La nature de l'univers chez l'animal," *La Nature*, Vol. 85 [1957], pp. 403–407, 438–443, 490–493, on p. 493). Analogous points are made by Boulding, *Image*, p. 29; Géza Révész, "The Problem of Space with Particular Emphasis on Specific Sensory Spaces," *American Journal of Psychology*, Vol. 50 (1937), p. 434n; Ernst Cassirer, *An Essay on Man: Introduction to a Philosophy of Human Culture* (New Haven: Yale University Press, 1944 and New York: Doubleday Anchor Books, n. d.), p. 67.

[31] Max Born, *Natural Philosophy of Cause and Chance* (Oxford: Clarendon Press, 1949), p. 125. For a critique on the formation of the common world view, see J. P. McKinney, "The Rational and the Real: Comment on a Paper by E. Topitsch," *Philosophy of Science*, Vol. 24 (1957), pp. 275–280.

[32] Bertrand Russell, *Our Knowledge of the External World* (New York: Mentor, 1960), p. 56. The question whether the so-called real world actually exists lies beyond the scope of this paper. As Russell says (p. 57), "universal skepticism, though logically irrefutable, is practically barren." Sanity and survival depend on the "sense of being a solid person surrounded by a solid world" (Money-Kyrle, *op. cit.* [see fn. 13], p. 96).

[33] Bertrand Russell, *Human Knowledge: Its Scope and Limits* (New York: Simon and Schuster, 1948), p. xii. But see J. K. Feibleman, "Knowing about Semipalatinsk," *Dialectica*, Vol. 9 (1955), pp. 3–4.

[34] Wright, "Terrae Incognitae," pp. 3–4. On the other hand, the consensual universe of discourse comprises elements from an infinite number of private worlds—not only those of existing persons, but also those that might conceivably be held. No square mile of the earth's surface has been seen from every possible perspective, but our view of the world in general is based on assumptions about such perspectives, as analogous with those that have been experienced. The Amazon basin would look different in design and detail from the top of every tree within it, but we know enough of the general character and major variations of that landscape to describe it adequately after climbing—or hovering in a helicopter over—a small fraction of its trees.

exploration than is the world we all share. "Like the earth of a hundred years ago," writes Aldous Huxley, "our mind still has its darkest Africas, its unmapped Borneos and Amazonian basins. ... A man consists of ... an Old World of personal consciousness and, beyond a dividing sea, a series of New Worlds—the not too distant Virginias and Carolinas of the personal subconscious ... ; the Far West of the collective unconscious, with its flora of symbols, its tribes of aboriginal archetypes; and, across another, vaster ocean, at the antipodes of everyday consciousness, the world of Visionary Experience. ... Some people never consciously discover their antipodes. Others make an occasional landing."[35]

To be sure, the general world view likewise transcends objective reality. The hopes and fears of mankind often animate its commonsense perceptions. The supposed location and features of the Garden of Eden stimulated medieval mapmakers; many useful journeys of exploration have sought elusive El Dorados. Delusion and error are no less firmly held by groups than by individuals. Metaphysical assumptions, from original sin to the perfectibility of man, not only color but shape the shared picture of the world. But fantasy plays a more prominent role in any private milieu than in the general geography. Every aspect of the public image is conscious and communicable, whereas many of our private impressions are inchoate, diffuse, irrational, and can hardly be formulated even to ourselves.

The private milieu thus includes much more varied landscapes and concepts than the shared world, imaginary places and powers as well as aspects of reality with which each individual alone is familiar. Hell and the Garden of Eden may have vanished from most of our mental maps, but imagination, distortion, and ignorance still embroider our private landscapes. The most compelling artifacts are but pale reflections of the lapidary architecture of the mind, attempts to recreate on earth the visionary images ascribed by man to God; and every marvel unattained is a Paradise Lost.[36]

In each of our personal worlds, far more than in the shared consensus, characters of fable and fiction reside and move about, some in their own lands, others sharing familiar countries with real people and places. We are all Alices in our own Wonderlands, Gullivers in Lilliput and Brobdingnag. Ghosts, mermaids, men from Mars, and the smiles of Cheshire cats confront us at home and abroad. Utopians not only make mythic men, they rearrange the forces of nature: in some worlds water flows uphill, seasons vanish, time reverses, or one- and two-dimensional creatures converse and move about. Invented worlds may even harbor logical absurdities: scientists swallowed up in the fourth dimension, conjurors imprisoned in Klein bottles, five countries each bordering on all the others.[37] Non-terrestrial geometries, topographical monsters, and abstract models of every kind in turn lend insight to views of reality. If we could not imagine the impossible, both private and public worlds would be the poorer.

Extent to Which Private Worlds Are Congruous with "Reality"

Though personal milieus in some respects fall short of and in others transcend the more objective consensual reality, yet they at least partly resemble it. What people perceive always pertains to the shared "real" world; even the landscapes of dreams come from actual scenes recently viewed or recalled from memory, consciously or otherwise, however much they may be distorted or transformed. Sensing can take place without external perception (spots before the eyes; ringing in the ears), but

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[35] *Heaven and Hell* (New York: Harper, 1955), pp. 1–3.

[36] "Man's spatialization of his world ... never appears to be exclusively limited to the pragmatic level of action and perceptual experience. ... Human beings in all cultures have built up a frame of spatial reference that has included the farther as well as the more proximal, the spiritual as well as the mundane, regions of their universe" (A. Irving Hallowell, *Culture and Experience* [Philadelphia: University of Pennsylvania Press, 1955], pp. 187–188). The genesis of these mental maps is explained in R. E. Money-Kyrle, *Man's Picture of His World: a Psycho-analytic Study* (London: Duckworth, 1960); see p. 171. For instances of theological location, see Erich Isaac, "Religion, Landscape and Space, *Landscape*, Vol. 9 (1959–60), pp. 14–18. The visionary transfiguration of the everyday world by means of gems and precious stones is a central theme in Huxley, *Heaven and Hell*.

[37] Edwin A. Abbott, *Flatland, a Romance of Many Dimensions* (New York: Dover, 1952 [London, 1884]), is a classic of two-dimensional life. For samples of the impossible, see Clifton Fadiman, ed., *Fantasia Mathematica* (New York: Simon and Schuster, 1958), notably Martin Gardner, "The Island of Five Colors," pp. 196–210.

"so expressive a phrase as 'the mind's eye' " is current, Smythies points out, because there is "something very like seeing about having sensory mental images.[38]

Illusions do not long delude most of us; "we see the world the way we see it because it pays us and has paid us to see it that way."[39] To find our way about, avoid danger, earn a living, and achieve basic human contacts, we usually have to perceive what is there. As the Sprouts express it, "the fact that the human species has survived (so far) suggests that there must be considerable correspondence between the milieu as people conceive it to be, and as it actually is."[40] If the picture of the world in our heads were not fairly consistent with the world outside, we should be unable to survive in any environment other than a mental hospital. And if our private milieus were not recognizably similar to one another, we could never have constructed a common world view.

Range and Limits of Personal Knowledge of the World

However, a perfect fit between the outside world and our views of it is not possible; indeed, complete fidelity would endanger survival. Whether we stay put or move about, our environment is subject to sudden and often drastic change. In consequence, we must be able to see things not only as they are, but also as they might become. Our private milieus are therefore flexible, plastic, and somewhat amorphous. We are physiologically equipped for a wide range of environments, including some of those that we create. But evolution is slow; at any point in time, some of our sensate and conceptual apparatus is bound to be vestigial, better suited to previous than to present milieus.

As individuals, we learn most rapidly about the world not by paying close attention to a single variable, but by superficially scanning a great variety of things. "Everyday perception tends to be selective, creative, fleeting, inexact, generalized, stereotyped" just because imprecise, partly erroneous impressions about the world in general often convey more than exact details about a small segment of it.[41] The observant are not necessarily most accurate; effective observation is never unwaveringly attentive. As Vernon emphasizes, "changing perceptions are necessary to preserve mental alertness and normal powers of thought." Awareness is not always conducive to survival. He who fails to see a tiger and hence does not attract its attention "may escape the destruction which his more knowing fellow invites by the very effects of his knowledge." So, Boulding concludes, "under some circumstances, ignorance is bliss and knowledge leads to disaster."[42]

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[38] J. R. Smythies, "The Problems of Perception," *British Journal for the Philosophy of Science*, Vol. 11 (1960), pp. 224–238, on p. 229; see also his *Analysis of Perception* (New York: Humanities Press, 1956), pp. 81–105. "The widespread belief that a mirage is something unreal, a sort of trick played on the eyes, is wrong. The picture a mirage presents is real but never quite accurate" (James H. Gordon, "Mirages," in *Smithsonian Institution, Annual Report for 1959* [Washington, D. C., 1960], pp. 327–346, on p. 328). On the form and content of landscapes in dreams, mirages, and hallucinations, and their relations with "reality," see Charles Fisher, "Dreams, Images and Perception: A Study of Unconscious-Preconscious Relationships," *Journal of the American Psychoanalytic Association*, Vol. 4 (1956), pp. 5–48; Charles Fisher and I. H. Paul, "The Effect of Subliminal Visual Stimulation on Images and Dreams: a Validation Study," *ibid.*, Vol. 7 (1959), pp. 35–83; Peter Hobart Knapp, "Sensory Impressions in Dreams," *Psychoanalytic Quarterly*, Vol. 25 (1956), pp. 325–347; C. T. K. Chari, "On the 'Space' and 'Time' of Hallucinations," *British Journal for the Philosophy of Science*, Vol. 8 (1958), pp. 302–306; Aldous Huxley, *The Doors of Perception* (London: Chatto and Windus, 1954).

[39] Boulding, *The Image*, p. 50.

[40] Harold Sprout and Margaret Sprout, *Man-Milieu Relationship Hypotheses in the Context of International Politics* (Princeton University Center of International Studies, 1956), p. 61. The essential correspondence between the perceived and the actual milieu is stressed in James J. Gibson, *The Perception of the Visual World* (Boston: Houghton Mifflin, 1950).

[41] *Ibid.*, p. 10; see also Miller, "The Magical Number Seven" [see fn. 12], pp. 88–89. We can count only a few of the stars or raindrops we see, beyond which everything becomes blurred; but our vagueness could not be rectified by looking longer or more carefully: "the blur is just as essential a feature of sense perception as other features are . . . . Sense perception is inexact in a very different sense from that in which . . . a map is inexact" (Waismann, "Analytic-Synthetic" [see fn. 6], *Analysis*, Vol. 13 [1953], pp. 76–77). Types and ranges of perception and learning are surveyed in M. D. Vernon, *A Further Study of Visual Perception* (Cambridge: The University Press, 1952); R. J. Hirst, *The Problems of Perception* (London: Allen & Unwin, 1959); James Drever, 2d., "Perceptual Learning," in *Annual Review of Psychology*, Vol. 11 (1960), pp. 131–160. For a concise theoretical review, see William Bevan, "Perception: Development of a Concept," *Psychological Review*, Vol. 65 (1958), pp. 34–55.

[42] Magdalen D. Vernon, "Perception, Attention and Consciousness," *Advancement of Science*, Vol. 16 (1959), pp. 111–123, on p. 120; Boulding, *The Image*,

Essential perception of the world, in short, embraces every way of looking at it: conscious and unconscious, blurred and distinct, objective and subjective, inadvertent and deliberate, literal and schematic.

Perception itself is never unalloyed: sensing, thinking, feeling, and believing are simultaneous, interdependent processes. A purely perceptual view of the world would be as lame and false as one based solely on logic, insight, or ideology. "All fact," as Goethe said, "is in itself theory." The most direct and simple experience of the world is a composite of perception, memory, logic, and faith. Looking down from a window, like Descartes, we say that we see men and women, when in fact we perceive no more than parts of hats and coats. The recognition of Mt. Monadnock, Chisholm demonstrates, is a conceptual as well as a visual act:[43]

> Suppose that you say to me, as we are riding through New Hampshire, "I see that that is Mt. Monadnock behind the trees." If I should ask, "How do you know it's Monadnock?" you may reply by saying, "I've been here many times before and I can *see* that it is." . . . If I still have my doubts about what you claim to see . . . I may ask, "What makes you *think* that's Monadnock that you see?" . . . An appropriate answer would be this: "I can see that the mountain is shaped like a wave and that there is a little cabin near the top. There is no other mountain answering to that description within miles of here." . . . What you now claim to see is, not that the mountain is Monadnock, but merely that it has a shape like a wave and that there is a cabin near the top. And this new "perceptual statement" is coupled with a statement of independent information ("Monadnock is shaped like a wave and there is a cabin near the top; no other mountain like that is within miles of here") —information acquired prior to the present perception.

And each succeeding perceptual statement can similarly be broken down into new perceptual claims and other additional information, until "we reach a point where we find . . . no *perceptual* claim at all."

UNIQUENESS OF PRIVATE MILIEUS

Despite their congruence with each other and with the world as it is, private milieus do diverge markedly among people in different cultures, for individuals within a social group, and for the same person as child and as adult, at various times and places, and in sundry moods. "The life of each individual," concludes Delagado, "constitutes an original and irreversible perceptive experience."[44]

Each private world view is unique, to begin with, because each person inhabits a different milieu. "The fact that no two human beings can occupy the same point at the same time and that the world is never precisely the same on successive occasions means," as Kluckhohn and Mowrer put it, that "the physical world is idiosyncratic for each individual." Experience is not only unique; more significantly, it is also self-centered; I am part of your milieu, but not of my own, and never see myself as the world does. It is usually one's self to which the world attends; "we will assume that an eye looks at us, or a gun points at us," notes Gombrich, "unless we have good evidence to the contrary."[45]

Each private world view is also unique because everyone chooses from and reacts to the milieu in a different way. We elect to see certain aspects of the world and to avoid others. Moreover, because "everything that we know about an object affects the way in which it appears to the eye," no object is apt to seem quite the same to any two percipients.[46] Thus "in some respects," as Clark says, "each man's appraisal of an identical situation is peculiarly his own."[47]

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p. 169. The classic story illustrating the virtues of ignorance of the geographical environment is in Kurt Koffka, *Principles of Gestalt Psychology* (New York: Harcourt-Brace, 1935), pp. 27–28.

[43] Chisholm, *Perceiving*, pp. 55–58; for the Descartes argument, from his *Meditations*, see pp. 154–56. See also Joseph R. Royce, "The Search for Meaning," *American Scientist*, Vol. 47 (1959), pp. 515–35; Ernst Cassirer, *The Philosophy of Symbolic Forms; Volume Three: The Phenomonology of Knowledge* (New Haven: Yale University Press, 1957), p. 25.

[44] Delgado, "A Possible Model for Ideas" [see fn. 12], p. 255.

[45] Clyde Kluckhohn and O. H. Mowrer, " 'Culture and Personality': a Conceptual Scheme," *American Anthropologist*, Vol. 46 (1944), pp. 1–29, on p. 13; E. H. Gombrich, *Art and Illusion: A Study in the Psychology of Pictorial Representation* (New York: Pantheon Books, 1960 [Bollingen Series, XXXV, No. 5]), p. 276. See also Sprout, *Man-Milieu Relationship Hypotheses*, p. 18.

[46] Vaughan Cornish, *Geographical Essays* (London: Sifton, Praed, [1946]), pp. 78–79.

[47] K. G. T. Clark, "Certain Underpinnings of Our Arguments in Human Geography," *Transactions of the Institute of British Geographers*, No. 16 (1950), pp. 13–22, on p. 20.

Cultural Differences in Aspects of World Views

Appraisals are, of course, profoundly affected by society and culture. Each social system organizes the world in accordance with its particular structure and requirements; each culture screens perception of the milieu in harmony with its particular style and techniques.[48]

Consider social and cultural differences in habits of location and techniques of orientation. Eskimo maps, Stefansson reports, often show accurately the number and shape of turns in routes and rivers, but neglect lineal distances, noting only how far one can travel in a day. The Saulteaux Indians do not think of circular motion, according to Hallowell; to go counterclockwise is to move, they say, from east to south to west to north, the birth order of the four winds in their mythology. To find their way about, some peoples utilize concrete and others abstract base points, still others edges in the landscape, or their own locations. The Chukchee of Siberia distinguish twenty-two compass directions, most of them tied to the position of the sun and varying with the seasons. The precise, asymmetrical navigation nets of Micronesian voyagers made use of constellations and islands. Tikopians, never far from the ocean, and unable to conceive of a large land mass, use *inward* and *seaward* to help locate anything: "there is a spot of mud on your seaward cheek."[49] In the Tuamotus, compass directions refer to winds, but places on the atolls are located by reference to their direction from the principal settlement. Westerners are more spatially egocentric than Chinese or Balinese. The religious significance of cardinal directions controls orientation indoors and out on the North China plain, and the Balinese give all directions in terms of compass points. Where we would say "go to the left," "towards me," or "away from the wall," they say "take the turn to the West," "pull the table southward," or, in case of a wrong note on the piano, "hit the key to the East of the one you are hitting."[50] Disorientation is universally disagreeable; but inability to locate north quite incapacitates the Balinese. The English writer Stephen Potter was amazed to find that most Americans neither knew nor cared what watershed they were in, or which way rivers flowed—facts he maintained were second nature to Englishmen.[51]

Apperception of shape is also culturally conditioned. According to Herskovits, an electrical

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[48] "Only exceptionally do we react in any literal sense to stimuli . . . . Rather, we react to our interpretations of stimuli. These interpretations are derived in considerable part from our culture and from each person's specific experiences in that culture" (Clyde Kluckhohn, "The Scientific Study of Values and Contemporary Civilization," *Proceedings of the American Philosophical Society*, Vol. 102 [1958], pp. 469–476, on p. 469). The classic case study is T. T. Waterman, *Yurok Geography* (Berkeley: University of California Press, 1920); see also Erik H. Erikson, *Childhood and Society* (New York: W. W. Norton, 1950), pp. 141–60. The literature on world views is ably summarized by Clyde Kluckhohn, "Culture and Behavior," in Gardner Lindzey, ed., *Handbook of Social Psychology*, 2 vols. (Cambridge, Mass.: Addison-Wesley, 1954), Vol. 2, pp. 921–976.

[49] Raymond Firth, *We, the Tikopia: a Sociological Study of Kinship in Primitive Polynesia* (London: Allen & Unwin, 1936), p. 19. For the previous examples, see the letter from Vilhjalmur Stefannson quoted in Erwin Raisz, *General Cartography* (New York: McGraw-Hill, 1948), p. 4; Hallowell, *Culture and Experience*, p. 201; Waldemar Bogoras, *The Chukchee. II.—Religion*. The Jesup North Pacific Expedition, Vol. VII, Memoir of the American Museum of Natural History (Leiden: Brill; New York: Stechert, 1907), pp. 303–304. The cultural and environmental contexts of orientation are considered at length in Hallowell, *op. cit.*, pp. 184–202, and Kevin Lynch, *The Image of the City* (Cambridge, Mass.: Technology Press and Harvard University Press, 1960), pp. 123–133.

[50] Bengt Danielsson, *Work and Life in Raroia: an Acculturation Study from the Tuamotu Group, French Oceania* (London: Allen & Unwin, 1956), pp. 30–31; Derk Bodde, "Types of Chinese Categorical Thinking," *Journal of the American Oriental Society*, Vol. 59 (1939), pp. 200–219, on p. 201n; Jane Belo, "The Balinese Temper," *Character and Personality*, Vol. 4 (1935), pp. 120–146, quote on pp. 126–127. Einar Haugen, "The Semantics of Icelandic Orientation," *Word*, Vol. 13 (1957), pp. 447–459, shows how cardinal orientation can depend on one's location with reference to an ultimate destination; thus an Icelander heading for the southern tip of the island is going "south" even if his coastwise route happens to be southwest or west. For other early or "primitive" methods of pathfinding, see B. F. Adler, *Maps of Primitive Peoples* (St. Petersburg, 1910), abridged by H. de Hutorowicz, *Bulletin of the American Geographical Society*, Vol. 43 (1911), pp. 669–679; Waldemar Bogoras, "Ideas of Space and Time in the Conception of Primitive Religion," *American Anthropologist*, Vol. 27 (1925), pp. 212–215; Pierre Jaccard, *Le Sens de la direction et l'orientation lointaine chez l'homme* (Paris: Payot, 1932); Harold Gatty, *Nature Is Your Guide: How to Find Your Way on Land and Sea by Observing Nature* (New York: Dutton, 1958).

[51] "I hardly found an American who knew which watershed he was in, which left me, as an Englishman who is uneasy unless he knows which ocean will receive his urination, somewhat scandalized" (*Potter on America* [London: Hart-Davis, 1956], p. 13).

engineer working in Ghana complained that "When a trench for a conduit must be dug, I run a line between the two points, and tell my workers to follow it. But at the end of the job, I invariably find that the trench has curves in it." In their land "circular forms predominate. . . . They do not live in . . . a carpentered world, so that to follow a straight line marked by a cord is as difficult for them" as drawing a perfect freehand circle is for most of us.[52] Zulus tested with the Ames trapezoidal window actually saw it as a trapezoid more often than Americans, who usually see it as a rectangle; habituated to man-made rectangular forms, we are apt unconsciously to assume that *any* four-sided object is a rectangle.[53]

Territoriality—the ownership, division, and evaluation of space—also differs from group to group. In American offices, workers stake out claims around the walls and readily move to accommodate new employees; but the Japanese gravitate toward the center of the room, and many Europeans are loathe to relinquish space once pre-empted. Eastern Mediterranean Arabs distinguish socially between right and left hand sides of outer offices, and value proximity to doors. In seeing and describing landscapes, Samoans emphasize the total impression, Moroccans the details. The Trukese sharply differentiate various parts of open spaces, but pay little attention to dividing lines or edges—a trait which makes land claims difficult to resolve.[54]

As with shapes, so with colors. Our most accustomed hues, such as blue and green, are not familiar in certain other cultures; whereas gradations scarcely perceptible to us may be part of their common experience. "There is no such thing as a 'natural' division of the spectrum," Ray concludes. "Each culture has taken the spectral continuum and has divided it into units on a quite arbitrary basis. . . . The effects of brightness, luminosity, and saturation are often confused with hue; and the resulting systems are emotional and subjective, not scientific."[55] Among the Hanunóo of Mindoro, Conklin shows, the most basic color terms refer to degrees of wetness (saturation) and brightness; hue is of secondary interest.[56]

As the diverse views of color suggest, it is not merely observed phenomena that vary with culture, but whole categories of experience. A simple percept here may be a complex abstraction there. Groupings of supreme importance in one culture may have no relevance in another. The Aleuts had no generic name for their island chain, since they did not recognize its unity. The Aruntas organize the night sky into separate, overlapping constellations, some out of bright stars, others out of faint ones. To the Trukese, fresh and salt water are unrelated substances. The gauchos of the Argentine are said to have lumped the vegetable world into four named groups: cattle fodder, bedding straw, woody material, and all other plants—including roses, herbs, and cabbages.[57] There is no natural or best way to classify anything; all categories are useful rather than true, and the landscape architect rightly prefers a mor-

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[52] Melville J. Herskovits, "Some Further Comments on Cultural Relativism," *American Anthropologist*, Vol. 60 (1958), pp. 266–273, on pp. 267–268.

[53] Gordon W. Allport and Thomas F. Pettigrew, "Cultural Influence on the Perception of Movement: the Trapezoidal Illusion among Zulus," *Journal of Abnormal and Social Psychology*, Vol. 55 (1957), pp. 104–113. Under "optimal" visual conditions, however, the Zulus mistook the trapezoid for a rectangle almost as often as Americans do, perhaps because most of them recognized it as a model of a Western-type window (Charles W. Slack, "Critique on the Interpretation of Cultural Differences in the Perception of Motion in Ames's Trapezoidal Window," *American Journal of Psychology*, Vol. 72 [1959], pp. 127–131). Another aspect of spatial perception which varies with culture is surveyed in Donald N. Michael, "Cross-Cultural Investigations of Closure," in David C. Beardslee and Michael Wertheimer, eds., *Readings in Perception* (New York: Van Nostrand, 1958), pp. 160–170.

[54] Edward T. Hall, *The Silent Language* (New York: Doubleday, 1959), pp. 197–200, and "The Language of Space," *Landscape*, Vol. 10 (1960), pp. 41–45; Thomas Gladwin and Seymour B. Sarason, *Truk: Man in Paradise*, Viking Fund Publications in Anthropology No. 20 (New York: Wenner-Gren, 1953), pp. 225–226, 269–270.

[55] Verne F. Ray, "Techniques and Problems in the Study of Human Color Perception," *Southwestern Journal of Anthropology*, Vol. 8 (1952), pp. 251–259, quotes on pp. 258–259; see also Ray, "Human Color Perception and Behavioral Response," *Transactions of the New York Academy of Sciences*, Ser. II, Vol. 16 (1953), pp. 98–104.

[56] Harold C. Conklin, "Hanunóo Color Categories," *Southwestern Journal of Anthropology*, Vol. 11 (1955), pp. 339–344.

[57] The Argentine data are cited in Karl Vossler, "Volkssprachen und Weltsprachen," *Welt und Wort*, Vol. 1 (1946), pp. 97–101, on p. 98, and discussed by Harold Basilius, "Neo-Humboldtian Ethnolinguistics," *Word*, Vol. 8 (1952), pp. 95–105, on p. 101. For the rest, see Gladwin and Sarason, *Truk*, p. 30, and Lynch, *op. cit.*, pp. 131–132.

phological to a genetic taxonomy. The patterns people see in nature also vary with economic, ethical, and esthetic values. Esthetically neutral to Americans, colors have moral connotations to Navahos; an Indian administrator's attempt to use colors as impartial voting symbols came to grief, since the Navahos viewed blue as good and red as bad.[58]

The Significance of Linguistic Differences in Apperception of the Milieu

The very words we use incline us toward a particular view of the universe. In Whorf's now classic phrase, "We dissect nature along lines laid down by our native languages. . . . We cut nature up, organize it into concepts, and ascribe significances as we do, largely because we are parties to an agreement to organize it in this way—an agreement that holds throughout our speech community."[59] To be sure, language also adjusts to the world view, just as environment molds vocabulary: within a single generation the craze for skiing has given us almost as many different words for *snow* as the Eskimos have.

Linguistic patterns do not irrevocably imprison the senses, but rather, Hoijer judges, "direct perception and thinking into certain habitual channels."[60] Things with names are easier to distinguish than those that lack them; the gauchos who used only four floristic terms no doubt saw more than four kinds of plants, but "their perceptual world is impoverished by their linguistic one."[61] Classifications into animate or inanimate, masculine, feminine, or neuter, and mass (sand, flour, grass, snow) or particular nouns (man, dog, thimble, leaf) variously affect the way different speech communities view things. We tend to think of waves, mountains, horizons, and martinis as though they were composed of discrete entities, but conceive surf, soil, scenery, and milk as aggregates, principally because the former terms are plurals, the latter indefinite nouns.[62]

[58] Hall, *Silent Language*, pp. 132–133. Many landscape features exist as separate entities only in our minds. As Gombrich says (*Art and Illusion*, p. 100), "There is a fallacy in the idea that reality contains such features as mountains and that, looking at one mountain after another, we slowly learn to generalize and form the abstract idea of mountaineity." Owing to the 19th-century popularity of Alpine climbing, the English standard of mountains changed dramatically: for Gilbert White the 800-foot Sussex Downs were "majestic mountains"; today anything below 2,000 feet is at best a "hill" (Vaughan Cornish, *Scenery and the Sense of Sight* (Cambridge: University Press, 1935), p. 77.

[59] "Science and Linguistics" [1940], in *Language, Thought, and Reality; Selected Writings of Benjamin Lee Whorf*, John B. Carroll, ed. (Cambridge, Mass.: Technology Press; New York: Wiley; London: Chapman and Hall, 1956), p. 213.

[60] Harry Hoijer, "The Relation of Language to Culture," in A. L. Kroeber *et al.*, *Anthropology Today: an Encyclopedic Inventory* (Chicago: University of Chicago Press, 1953), pp. 554–573, on p. 560.

[61] Garrett Hardin, "The Threat of Clarity," *ETC.: a Review of General Semantics*, Vol. 17 (1960), pp. 269–278, on p. 270. Similarly, people more readily perceive and identify colors that have widely-known specific names (like blue and green) than those that do not (Roger W. Brown and Eric H. Lenneberg, "A Study in Language and Cognition," *Journal of Abnormal and Social Psychology*, Vol. 49 [1954], pp. 454–462).

[62] "English terms, like 'sky, hill, swamp,' persuade us to regard some elusive aspect of nature's endless variety as a distinct THING, almost like a table or chair" (Whorf, *Language, Thought, and Reality*, p. 240; see also pp. 140–141). But Roger W. Brown (*Words and Things* [Glencoe, Ill.: Free Press, 1958], pp. 248–252) maintains that the distinction between mass and specific nouns makes perceptual sense and corresponds well with perceived reality.

One can easily, as critics of Whorf have pointed out, make too much of such distinctions. The fact that the word for *sun* is masculine in French and feminine in German, whereas that for *moon* is feminine in French and masculine in German, cannot easily be correlated with the habits of thought or *Weltanschauung* of either people. The fact that in Algonquian languages the gender class of "animate" nouns includes such words as *raspberry*, *stomach*, and *kettle*, while "inanimate" nouns include *strawberry*, *thigh*, and *bowl* does not imply "that speakers of Algonquian have a shrine to the raspberry and treat it like a spirit, while the strawberry is in the sphere of the profane" (Joseph H. Greenberg, "Concerning Inferences from Linguistic to Nonlinguistic Data," in Harry Hoijer, ed., *Language in Culture*, American Anthropological Association, Memoir No. 79 [Chicago, 1954], pp. 3–19, on pp. 15–16). In short, "If grammar itself was once founded on an unconscious metaphysic, this linkage is now so vestigial as to have no appreciable bearing on the structure of philosophic ideas" (Lewis S. Feuer, "Sociological Aspects of the Relation Between Language and Philosophy," *Philosophy of Science*, Vol. 20 [1953], pp. 85–100, on p. 87). This may be true of most aspects of language, and of philosophical ideas in their broadest sense. On the other hand, the fact that English-speaking mid-Victorians clad table and piano legs in ruffs and deplored direct reference to them in mixed company was not a necessary outgrowth of prudery but depended also on the metaphorical extension of the word for human limbs to furniture—a connection not made by speakers of other languages. In this respect, language certainly altered the English—and still more the American—home landscape.

The structural aspects of language influence ways of looking at the world more than do vocabularies. Seldom consciously employed, usually slow to change, syntax pervades basic modes of thought. In Shawnee, La Barre suggests, "I let her have one on the noggin" is grammatically analogous to "The damned thing slipped out of my hand."[63] Lacking transitive verbs, Greenlanders tend to see things happen without specific cause; "I kill him," in their language, becomes "he dies to me." In European tongues, however, action accompanies perception, and the transitive verb animates every event with purpose and cause. The Hopis have subjectless verbs, but most Indo-European subjects have objects, which gives expression a dualistic, animistic stamp. In Piaget's illustration, to say "the wind blows" "perpetrates ... the triple absurdity of suggesting that the wind can be independent of the action of blowing, that there can be a wind that does not blow, and that the wind exists apart from its outward manifestations."[64] Important differences also occur within linguistic families. The French distinction between the imperfect tense (used for things and processes) and the perfect (used for man and his actions) contrasts the uniformity of nature with the uniqueness of man in a way that English does not ordinarily express.

That such distinctions can all be conveyed in English shows that language does not fetter thought; with sufficient care and effort, practically everything in any system of speech can be translated. Nevertheless, a concept that comes naturally and easily in one tongue may require awkward and tedious circumlocution in another. The difference between what is customary for some but difficult for others is apt to be crucial in terms of habits of thought and, perhaps, orders of events. European scientists, whose languages lump processes with substances as nouns, took much longer to account for vitamin deficiencies than for germ diseases, partly because "I have a germ" was a more natural locution than "I have a lack of vitamins." In short, as Waismann says, "by growing up in a certain language, by thinking in its semantic and syntactical grooves, we acquire a certain more or less uniform outlook on the world. ... Language shapes and fashions the frame in which experience is set, and different languages achieve this in different ways."[65]

Personal Variations in Aspects of the World View

Private world views diverge from one another even within the limits set by logical necessity, human physiology, and group standards. In any society, individuals of similar cultural background, who speak the same language, still perceive and understand the world differently.

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[63] Weston La Barre, *The Human Animal* (Chicago: University of Chicago Press, 1954), p. 204. See Whorf, *op. cit.*, p. 235.

[64] Piaget, *Child's Conception of the World*, p. 249. A book has been written to tell parents how to answer a child who asks such questions as "what does the wind do when it's not blowing?" (Ruth Purcell, "Causality and Language Rigidity," *ETC.*, Vol. 15 [1958], pp. 173–180, on p. 179). Whorf (*Language, Thought, and Reality*) compares Hopi language and thought with that of "Standard Average European" in several papers (*e. g.*, pp. 57–64, 134–159, 207–219).

Unlike most psychologists and anthropologists, geographers have tended to assume, with positivistic philosophers, that we could rid ourselves of animistic and teleological kinds of explanation and ways of looking at the world by substituting other words and phrases in our language. "Ritter's teleological views ... though they colour every statement he makes, yet do not affect the essence," according to H. J. Mackinder; "it is easy to re-state each proposition in the most modern evolutionary terms" (President's address, Section E, British Association for the Advancement of Science, *Report of the 65th Annual Meeting*, Ipswich, 1895 [London: Murray, 1895] pp. 738–748, on p. 743); that is, Mackinder found it easy to accommodate Ritter's brand of determinism to his own. For other views on the relation between teleological language and habits of thought, see Sprout, *Man-Milieu Relationship Hypotheses*, pp. 27–28; A. J. Bernatowicz, "Teleology in Science Teaching," *Science*, Vol. 128 (1958), pp. 1402–1405; Ernest Nagel, "Teleological Explanation and Teleological Systems," in Feigl and Brodbeck, *Readings in the Philosophy of Science*, pp. 537–558; Karl A. Sinnhuber, "Karl Ritter 1779–1859," *Scottish Geographical Magazine*, Vol. 75 (1959), p. 160.

[65] Waismann, "Analytic-Synthetic" [see fn. 6], *Analysis*, Vol. 13 (1952), p. 2. "The fact that an ethnologist can describe in circumlocution certain distinctions in kin that are *customarily* made by the Hopi does not alter his conclusion that the Hopi name kin and behave toward them differently from us" (Harry Hoijer, review of Roger W. Brown, *Words and Things*, in *Language*, Vol. 35 [1959], pp. 496–503, on p. 501). For a range of views on metalinguistics see Eric H. Lenneberg, "Cognition in Ethnolinguistics," *Language*, Vol. 29 (1953), pp. 463–71; Franklin Fearing, "An Examination of the Conceptions of Benjamin Whorf in the Light of Theories of Perception and Cognition," in Hoijer, ed., *Language and Culture*, pp. 47–81; Anatol Rapoport and Arnold Horowitz, "The Sapir-Whorf-Korzybski Hypothesis: a Report and a Reply," *ETC.*, Vol. 17 (1960), pp. 346–363.

"You cannot see things until you know roughly what they are," comments C. S. Lewis, whose hero on the planet Malacandra at first perceives "nothing but colours—colours that refused to form themselves into things."[66] But what you think you know depends both on what is familiar to you and on your proclivities. When the well-known is viewed from fresh perspectives, upside down or through distorting lenses, form and color are enhanced, as Helmholtz noted; the unexpected has a vivid, pictorial quality. On the other hand, prolonged observation may change red to apparent green, or shrink a figure in proportion to its surroundings.[67]

The purpose and circumstances of observation materially alter what is seen. The stage electrician cares how the lights look, not about the actual colors of the set; the oculist who tests my eyes is not interested in what the letters are, but in how they appear to me. Intent modifies the character of the world.[68]

Outside the laboratory, no two people are likely to see a color as the same unless they similarly identify the thing that is colored. Even then, preconceptions shape appearances, as Cornish points out: "The exquisite colours which light and atmosphere impart to a snowy landscape are only half seen by many people owing to their opinion that 'snow is really white.' "[69] Such stereotypes may outweigh other physiological facts. The United States Navy was advised to switch the color of survival gear and life jackets from yellow to fluorescent red, not so much to increase visibility as to buoy the confidence of the man lost at sea; dressed in red, he imagines, "They can't fail to see me."[70]

The way a landscape looks depends on all the attendant circumstances, for each sense is affected by the others. Velvet looks soft, ice sounds solid, red feels warm because experience has confirmed these impressions. The sight of gold and blond beech trees lit by sunlight made Cornish forget that he was cold; but he could not appreciate a "frosty" blue landscape seen from a cold railway carriage. "Quite often," notes H. M. Tomlinson, "our first impression of a place is also our last, and it depends solely upon the weather and the food."[71]

Circumstance apart, each person is distinctively himself. "The individual carries with him into every perceptual situation . . . his characteristic sensory abilities, intelligence, interests, and temperamental qualities," according to Vernon; and his "responses will be coloured and to some extent determined by these inherent individual qualities."[72] Ability to estimate vertical and horizontal correctly, for example, varies with sex and personality as well as with maturity: strongminded men are better at telling which way is up than are women, neurotics, and children, whose kinesthetic sense reinforces visual perception less adequately.[73] The story of the Astronomer-Royal, Maskeleyne, who dismissed a faithful assistant for persistently recording the passage of stars more than half a second later than he did, is often told to illustrate the inevitability of perceptual divergence

[66] *Out of the Silent Planet* (New York: Macmillan, 1952), p. 40.

[67] For Helmholtz, see Cassirer, *Philosophy of Symbolic Forms*, Vol. 3, pp. 131–132. On changes in apparent color and size, see T. N. Cornsweet *et al.*, "Changes in the Perceived Color of Very Bright Stimuli," *Science*, Vol. 128 (1958), pp. 898–899; Dorothea Jameson and Leo M. Hurvich, "Perceived Color and Its Dependence on Focal, Surrounding, and Preceding Stimulus Variables," *Journal of the Optical Society of America*, Vol. 49 (1959), pp. 890–898; Wolfgang Köhler, *Dynamics in Psychology* (New York: Grove Press, 1960 [1940]), pp. 84–86.

[68] "Without the conception of the individual and his needs, a distinction between illusion and 'true' cognition cannot be made" (Horace B. English, "Illusion as a Problem in Systematic Psychology," *Psychological Review*, Vol. 58 [1951], pp. 52–53). The size and shape of objects seem appropriately and necessarily constant, but most of us can afford to be "fooled" by the apparent bending of a stick half-submerged in water.

[69] Cornish, *Scenery and the Sense of Sight*, p. 22. On the dissimilar impressions of identical shapes and colors, see Karl Duncker, "The Influence of Past Experience upon Perceptual Properties," *American Journal of Psychology*, Vol. 52 (1939), pp. 255–265; Jerome S. Bruner and Leo Postman, "Expectation and the Perception of Color," *American Journal of Psychology*, Vol. 64 (1951), pp. 216–227; Arthur Kapp, "Colour-Image Synthesis with Two Unorthodox Primaries," *Nature*, Vol. 184 (1959), pp. 710–713; Edwin H. Land, "Experiments in Color Vision," *Scientific American*, Vol. 200, No. 5 (May 1959), pp. 84–99.

[70] "Navy Research on Color Vision," *Naval Research Reviews* (October, 1959), p. 19.

[71] *The Face of the Earth; with Some Hints for Those About to Travel* (Indianapolis: Bobbs-Merrill, 1951), p. 52.

[72] Vernon, *A Further Study of Visual Perception*, p. 255.

[73] H. A. Witkin *et al.*, *Personality Through Perception: an Experimental and Clinical Study* (New York: Harper, 1954); Herman A. Witkin, "The Perception of the Upright," *Scientific American*, Vol. 200, No. 2 (February 1959), pp. 51–56.

under the best of circumstances.[74] Each of us warps the world in his own way and endows landscapes with his particular mirages.

People at home in the same environments, for example, habitually select different modes of orientation. There is only one published "New Yorker's Map of the United States," but Trowbridge found a great variety of personal imaginary maps. Individual deviations of direction ranged from zero to 180 degrees off course; some were consistent, others more distorted at Times Square than at the Battery, or accurate about Albany but not about Chicago. Still others assumed that streets always point towards cardinal directions, or imagined all distant places as lying due east or west. A few know which direction they face the moment they emerge from subways and theatres, others are uncertain, still others are invariably mistaken. Lynch characterizes structural images of the environment as positional, disjointed, flexible, and rigid, depending on whether people orient themselves principally by distant landmarks, by memories of details in the landscape, by crossings, street turns, or directions, or by maps.[75]

Subjective Elements in Private Geographies

Another reason why private world views are irreducibly unique is that all information is inspired, edited, and distorted by feeling. Coins look larger to the children of the poor,[76] the feast smells more fragrant to the hungry, the mountains loom higher to the lost. "Had our perceptions no connexion with our pleasures," wrote Santayana, "we should soon close our eyes on this world."[77] We seldom differentiate among people, places, or things until we have a personal interest in them. One American town is much like another to me, unless I have a good motive for telling them apart. The most exhaustive study of photographs and ethnological evidence does not enable us to distinguish among individuals of another race with the ease, speed, and certainty generated by strong feeling. All Chinese may look the same to me, but not to the man—however foreign—with a Chinese wife. Only the flea circus owner can tell you which is which among his performing fleas.[78]

Stereotypes influence how we learn and what we know about every place in the world. My notions of Australia and Alaska are compounds of more or less objective, veridical data and of the way I happen to feel about deserts, icefields, primitive peoples, pioneers, amateur tennis, and American foreign policy. Similar evanescent images come readily to mind; to Englishmen in the 1930's, according to one writer, Kenya suggested "gentleman farmers,

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[74] Polanyi, *Personal Knowledge*, pp. 19–20, recounts this and similar episodes. H. J. Eysenck, "Personality and the Perception of Time," *Perceptual and Motor Skills*, Vol. 9 (1959), pp. 405–406, shows that introverts and extroverts clock the passage of time at systematically different rates. See also John R. Kirk and George D. Talbot, "The Distortion of Information," *ETC.*, Vol. 17 (1959), pp. 5–27; Melvin Wallace and Albert I. Rubin, "Temporal Experience," *Psychological Bulletin*, Vol. 57 (1960), pp. 221–223.

[75] C. C. Trowbridge, "On Fundamental Methods of Orientation and 'Imaginary' Maps," *Science*, Vol. 38 (1913), pp. 891–892; Lynch, *Image of the City*, pp. 88–89, 136–137. See also T. A. Ryan and M. S. Ryan, "Geographical Orientation," *American Journal of Psychology*, Vol. 53 (1940), pp. 204–215.

[76] Jerome S. Bruner and Cecile C. Goodman, "Value and Need as Organizing Factors in Perception," *Journal of Abnormal and Social Psychology*, Vol. 42 (1947), pp. 33–44. Further tests yielded significant differences in size estimation principally when coins were judged from memory (Launor F. Carter and Kermit Schooler, "Value, Need, and Other Factors in Perception," *Psychological Review*, Vol. 56 [1949], pp. 200–207), but the initial general hypothesis has been substantially confirmed (J. S. Bruner and George S. Klein, "The Functions of Perceiving: New Look Retrospect," in Bernard Kaplan and Seymour Wapner, eds., *Perspectives in Psychological Theory: Essays in Honor of Heinz Werner* [New York: International Universities Press, 1960], p. 67).

[77] George Santayana, *The Sense of Beauty; Being the Outline of Aesthetic Theory* [1896] (New York: Dover Publications, 1955), p. 3. "I cannot," writes Gardner Murphy, "find an area where hedonistic perceptual theory cannot apply" ("Affect and Perceptual Learning," *Psychological Review*, Vol. 63 [1956], p. 7).

[78] Anton Ehrenzweig, *The Psycho-Analysis of Artistic Hearing and Vision: an Introduction to a Theory of Unconscious Perception* (New York: Julian Press, 1953), p. 170. See also James J. Gibson and Eleanor J. Gibson, "Perceptual Learning: Differentiation or Enrichment?" *Psychological Review*, Vol. 62 (1955), pp. 32–41. Science is more often apt to be accelerated "by the passionate, and even the egocentric partisan bias of researchers in favour of their own chosen methods or theories" than by disinterested impartiality (W. B. Gallie, "What Makes a Subject Scientific?" *British Journal for the Philosophy of Science*, Vol. 8 [1957], pp. 118–139, on p. 127). Metaphysical doctrines which can neither be proved nor disproved "play regulative roles in scientific thinking" because "they express ways of seeing the world which in turn suggest ways of exploring it" (J. W. N. Watkins, "Confirmable and Influential Metaphysics," *Mind*, Vol. 67 [1958], pp. 344–365, on pp. 360, 356).

the seedy aristocracy, gossip columns and Lord Castlerosse"; South Africa "Rhodes and British Empire and an ugly building in South Parks Road and Trafalgar Square."[79] Education and the passage of time revise but never wholly displace such stereotypes about foreign lands and people. The present consensus of teen-aged geography students in an English school is that "South Africans break off from the Boer War to eat oranges, make fortunes from gold and diamonds, and oppress natives, under a government as merciless as the ever-present sun."[80] Those who think of China as an abode of laundrymen, France as a place where people eat snails, and the Spanish as hotblooded are only a trifle more myopic than anyone else; it is easier to deplore such generalizations than to replace them with more adequate and convincing images.

Because all knowledge is necessarily subjective as well as objective, delineations of the world that are purely matter-of-fact ordinarily seem too arid and lifeless to assimilate; only color and feeling convey versimilitude. Besides unvarnished facts, we require fresh firsthand experience, individual opinions and prejudices. "The important thing about truth is not that it should be naked, but what clothes suit it best."[81] The memorable geographies are not compendious texts but interpretative studies embodying a strong personal slant. A master at capturing the essence of a place, Henry James did so by conveying "less of its appearance than of its implications."[82] In Blake's lines,[83]

> This Life's dim Windows of the Soul
> Distorts the Heavens from Pole to Pole
> And leads you to Believe a Lie
> When you see with, not thro', the Eye.

The ideal traveler, according to one critic, ought to be "aware not only of the immediate visual aspect of the country he visits, its history and customs, its art and people, but also of his own relation to all these, their symbolic and mythic place in his own universal map."[84] We mistrust science as the sole vehicle of truth because we conceive of the remote, the unknown, and the different in terms of what is near, well-known, and self-evident for us, and above all in terms of ourselves. What seems to us real and true depends "on what we know about ourselves and not only on what we know about the external world. Indeed," writes Hutten, "the two kinds of knowledge are inextricably connected."[85]

The Role of the Individual Past in Apperception of the Milieu

Personal as well as geographical knowledge is a form of sequent occupance. Like a landscape or a living being, each private world has

[79] Graham Green, "The Analysis of a Journey," *Spectator*, Vol. 155 (1935), pp. 459–460. "Even if we remember as many facts about Bolivia as about Sweden, this has little relevance to the relative importance of these two countries in our psychological world" (Robert B. MacLeod, "The Phenomenological Approach to Social Psychology," *Psychological Review*, Vol. 54 [1947], p. 206).

[80] John Haddon, "A View of Foreign Lands," *Geography*, Vol. 65 (1960), pp. 286–289, on p. 286. If their view of South Africa is recognizable, the students' impressions of America leave more to be desired: "America is a country of remarkably developed, highly polished young women, and oddly garbed, criminally inclined young men travelling at great speed in monstrous cars along superhighways from one skyscraping city to the next; the very largest cars contain millionaires with crew-cuts; everyone is chewing gum" (p. 286). Such stereotypes die hard, even face to face with contrary realities, as one traveler noted among Americans in Russia (Richard Dettering, "An American Tourist in the Soviet Union: Some Semantic Reflections," *ETC.*, Vol. 17 [1960], pp. 173–201).

[81] Russell Brain, *The Nature of Experience* (London: Oxford University Press, 1959), p. 3.

[82] A. Alvarez, "Intelligence on Tour," *Kenyon Review*, Vol. 21 (1959), pp 23–33, on p. 29; see Henry James, *The Art of Travel*, Morton D. Zaubel, editor, (New York: Doubleday, 1958). The virtues of the personal slant on description are discussed by Freya Stark, "Travel Writing: Facts or Interpretation?" *Landscape*, Vol. 9 (1960), p. 34, and Wright, "Terrae Incognitae" [see fn. 2], p. 8.

[83] William Blake, "The Everlasting Gospel" [c. 1818], in *Selected Poetry and Prose*, pp. 317–328, on p. 324.

[84] Peter Green, "Novelists and Travelers," *Cornhill Magazine*, Vol. 168 (1955), pp. 39–54, on p. 49. "Man can discover and determine the universe inside him only by thinking it in mythical concepts and viewing it in mythical images" (Cassirer, *Philosophy of Symbolic Forms*, Vol. 2, p. 199; see also pp. 83, 101).

[85] Ernest H. Hutten, "[review of] *Sigmund Freud: Life and Work*, Vol. 3, by Ernest Jones," *British Journal for the Philosophy of Science*, Vol. 10 (1959), p. 81. Experience always influences the severest logic: no matter how convinced a man is that heads and tails have exactly equal prospects, he is not likely to bet on tails if heads has come up the previous fifty times (Popper, *Logic of Scientific Discovery*, pp. 408, 415; John Cohen, *Chance, Skill, and Luck: the Psychology of Guessing and Gambling* [Baltimore: Penguin Books, 1960, pp. 29, 191]). See also Ernst Topitsch, "World Interpretation and Self-Interpretation: Some Basic Patterns," *Daedalus*, Vol. 88 (Spring, 1959), p. 312.

had a career in time, a history of its own. Since personality is formed mainly in the earliest years, "we are determined, simultaneously, both by what we were as children and by what we are experiencing now." In Quine's words, "We imbibe an archaic natural philosophy with our mother's milk. In the fullness of time, what with catching up on current literature and making some supplementary observations of our own, we become clearer on things. But . . . we do not break with the past, nor do we attain to standards of evidence and reality different in kind from the vague standards of children and laymen."[86]

The earlier mode of thought continues throughout life. According to Portmann, we all remain to some extent pre-Copernican: "The decisive early period in our contact with nature is strongly influenced by the Ptolemaic point of view, in which our inherited traits and responses find a congenial outlet. . . . Nor is the Ptolemaic world merely a phase to be outgrown, a kind of animal experience; it is an integral part of our total human quality."[87]

As every personal history results in a particular private milieu, no one can ever duplicate the *terra cognita* of anyone else. An adult who learns a foreign word or custom does not start from *tabula rasa*, but tries to match concepts from his own language and culture—never with complete success. Among "children, exposed serially to two cultures," notes Mead, ". . . the premises of the earlier may persist as distortions of perception into later experience, so that years later errors in syntax or reasoning may be traced to the earlier and 'forgotten' cultural experience."[88]

We are captives even of our adult histories. The image of the environment, as Boulding says, "is built up as a result of all past experience of the possessor of the image. Part of the image is the history of the image itself." I have touched on this in connection with color perception: "The color in which we have most often seen a thing is imprinted ineffaceably on our memory and becomes a fixed attribute of the remembered image," says Hering. "We see through the glass of remembered colors and hence often differently than we should otherwise see them."[89] The sitter's family invariably complain that the painter has made him look too old, because they view as a composite memory the face the painter confronts only today. "Everyone sees the world as it was in the past, reflected in the retarding mirror of his memory."[90]

Memory need not be conscious to influence images; as Hume pointed out, aspects of our past that we fail to recall also leave their imprint on mental maps. "The unconscious inner world," writes Money-Kyrle, "is peopled by figures and objects from the past, as they are imagined often wrongly to have been." Correct or not, recollections can virtually efface aspects of the actual contemporary landscape. Pratolini's *Il Quartiere* portrays inhabitants of a razed and empty section of Florence who instinctively continued to follow the lines of the former streets, instead of cutting diagonally across the square where buildings had stood.[91]

Memory likewise molds abstract ideas and hypotheses. Everything I know about America today is in part a memory of what I used to think about it. Having once conceived of the frontier as a cradle of democracy, it is quite another thing for me to learn that it was not than it is for someone else to learn the "true" fact without the old error. What we accept as true or real depends not only on what we think

[86] Hutten, *op. cit.*, p. 79; Quine, "Scope and Language of Science" [see fn. 5], p. 2.

[87] Portmann, "The Seeing Eye," *Landscape*, Vol. 9 (1959), p. 18. See also D. O. Hebb, *The Organization of Behavior; a Neuropsychological Theory* (New York: Wiley, 1949), p. 109; Felix Deutsch, "Body, Mind, and Art," in *The Visual Arts Today*, special issue of *Daedalus*, Vol. 89 (Winter, 1960), pp. 34–45, on p. 38; Edward S. Tauber and Maurice R. Green, *Prelogical Experience: an Inquiry into Dreams and Other Creative Processes* (New York: Basic Books, 1959), p. 33.

[88] Magorah Maruyama, "Communicable and Incommunicable Realities," *British Journal for the Philosophy of Science*, Vol. 10 (1959), pp. 50–54; Margaret Mead, "The Implications of Culture Change for Personality Development," *American Journal of Orthopsychiatry*, Vol. 17 (1947), pp. 633–646, on p. 639.

[89] Boulding, *The Image*, p. 6; Ewald Hering, *Grundzüge der Lehre vom Lichtsinn* (Berlin: Springer, 1920), pp. 6 ff.; quoted in Cassirer, *Philosophy of Symbolic Forms*, Vol. 3, pp. 132–133. See also J. S. Bruner and Leo Postman, "On the Perception of Incongruity: a Paradigm," in Beardslee and Wertheimer, *Readings in Psychology*, pp. 662–663; Bruner and Klein, "Functions of Perceiving" [see fn. 78], p. 63.

[90] Maurice Grosser, *The Painter's Eye* (New York: Rinehart, 1951), p. 232.

[91] David Hume, *A Treatise of Human Nature* [1739], Book I, part iv, sec. vi; Money-Kyrle, *Man's Picture of His World*, p. 107; Vasco Pratolini, *The Naked Streets* (New York: A. A. Wyn, 1952), p. 204.

we know about the external world but on what we have previously believed.

Shared perspectives of whole cultures similarly incorporate the past. "Meanings may reflect not the contemporary culture but a much older one." The landscape in general, Lynch remarks, "serves as a vast mnemonic system for the retention of group history and ideals."[92]

CONCLUSION

Every image and idea about the world is compounded, then, of personal experience, learning, imagination, and memory. The places that we live in, those we visit and travel through, the worlds we read about and see in works of art, and the realms of imagination and fantasy each contribute to our images of nature and man. All types of experience, from those most closely linked with our everyday world to those which seem furthest removed, come together to make up our individual picture of reality.[93] The surface of the earth is shaped for each person by refraction through cultural and personal lenses of custom and fancy. We are all artists and landscape architects, creating order and organizing space, time, and causality in accordance with our apperceptions and predilections. The geography of the world is unified only by human logic and optics, by the light and color of artifice, by decorative arrangement, and by ideas of the good, the true, and the beautiful. As agreement on such subjects is never perfect nor permanent, geographers too can expect only partial and evanescent concordance. As Raleigh wrote, "It is not truth but opinion that can travel the world without a passport."[94]

[92] Kluckhohn, "Culture and Behavior" [see fn. 48], p. 939; Lynch, *Image of the City*, p. 126.

[93] As natives of places we acquire and assimilate information differently than we do as travelers; and personal observation, whether sustained or casual, yields impressions different in quality and impact from those we build out of lectures, books, pictures, or wholly imaginary visions. The climates of each of these modes of geographical experience, and the kind of information they tend to yield about the world, will be considered in a series of essays to which this one is meant to be introductory.

[94] Quoted in C. V. Wedgwood, *Truth and Opinion: Historical Essays* (London: Collins, 1960), p. 11.

FRONTIERS OF SETTLEMENT IN THE GREAT CLAY BELT, ONTARIO AND QUEBEC[1]

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THE westward advance of the American frontier had ended by 1890, but the Canadian frontier of agricultural settlement continued to move westward and northward. At the beginning of the second quarter of the twentieth century, only two large areas of potentially arable land in Canada remained open for settlement. These two areas, the Peace River Country of western Alberta and the Great Clay Belt of northeastern Ontario and northwestern Quebec, are enclaves beyond the zone of continuous agricultural settlement. The Great Clay Belt is of special interest to the geographer, for it is shared by two provinces, with differences in cultural environment, religion, and philosophy of colonization that have resulted in strong contrasts in population numbers and distribution, method of settlement, and rate of settlement growth.

Many of the pioneer settlement studies initiated or inspired by Isaiah Bowman were concerned with the economy of the fringe settlements, hence the term "pioneer" was used. The term "frontier" seems more appropriate in this study, for it refers to the area or zone between the settled and unsettled or used and unused land.[2] It is in this context that the term frontier is used here.

In his preface to *The Pioneer Fringe*, Bowman states that "settlement habitually advances and retreats on the outer fringe of land occupation."[3] Since Bowman's writing, Stone has been the only geographer to refer to advancing and retreating frontiers of settlement, which he has shown cartographically for Anglo-America.[4] This paper is concerned with the simultaneous advance and retreat of the agricultural frontier in the physically homogeneous Great Clay Belt.

The Great Clay Belt lies almost entirely within two counties: Cochrane, Ontario, and Abitibi, Quebec (Fig. 1). The gray clay, which was laid down in a temporary glacial lake, is estimated to cover sixteen million acres in northern Ontario and thirteen million acres in northern Quebec.[5] However, only 3 percent of this total is improved farm land. Even within

FIG. 1. Location of the Clay Belt. The Great and Little Clay Belts are the largest clay pockets on the Canadian Shield. Because the frontiers of the Little Clay Belt have become stabilized, it is not included in this study.

[1] This study was supported in part by a grant from the Danforth Foundation. Grateful acknowledgment is given to Professors Kirk H. Stone and Andrew H. Clark of the University of Wisconsin for their suggestions.

[2] Kirk H. Stone, "Human Geographic Research in the North American Northern Lands," *Arctic Research*, Special Publication No. 2 of the Arctic Institute of North America, 1956, p. 218.

[3] Isaiah Bowman (ed.), *The Pioneer Fringe* (New York: American Geographical Society, 1931), p. v.

[4] Stone, *op. cit.*, p. 210.

[5] A. Gosselin and G. P. Boucher, *Settlement Problems in Northwestern Quebec and Northeastern Ontario*, Publication No. 758, Dominion of Canada Department of Agriculture, 1944, p. 8.

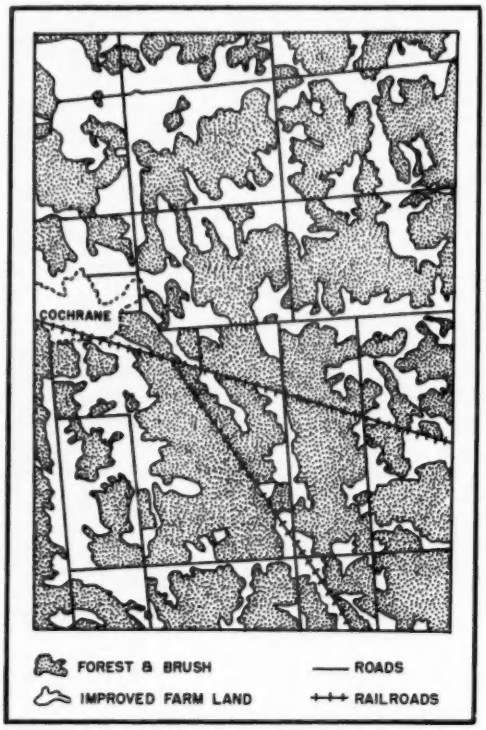

FIG. 2. Land use in the Cochrane area, *circa* 1955. Scale approximately 1:120,000. (Redrawn from Royal Canadian Airforce Photograph.)

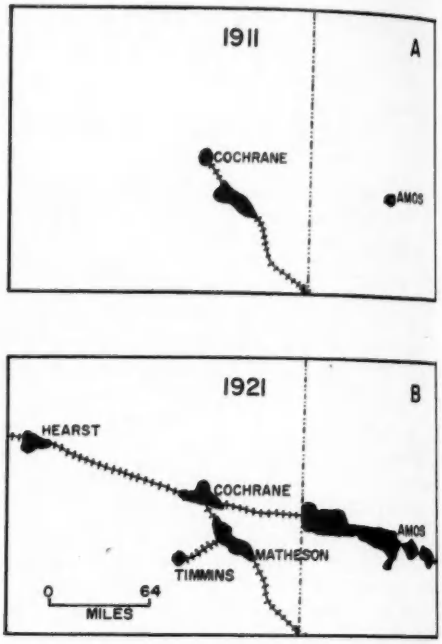

FIG. 3. The spread of settlement in the Great Clay Belt, 1911–1921. (Source: *Census of Canada, Population.*)

one of the oldest and most thickly settled rural areas near the village of Cochrane, forest and brush occupy two-thirds of the land (Fig. 2).

POPULATION AND SETTLEMENT

The first agricultural settlements in the Great Clay Belt formed a ribbon-like pattern along the Timiskaming and Northern Ontario Railroad beginning south of Matheson and extending northward toward the village of Cochrane (Fig. 3A). Even before the railroad was completed to Cochrane, settlers had begun to establish farms in the area,[6] and at least a year before the Canadian National Railroad reached the site of Amos, settlers had begun making clearings in its vicinity[7] (Fig. 3A).

When the Canadian National Railroad was completed across the Clay Belt in 1913, settlement spread discontinuously along it from the village of Cochrane to Hearst (Fig. 3B). In Abitibi, settlement spread along the railroad from a nucleus at Amos to the present eastern and western limits of settlement in less than ten years (Figs. 3A, 3B, and 4B). Even from the beginning, the area of settlement has been more compact in Abitibi than in Cochrane. By 1931, the areas of settlement in Cochrane had reached their present proportions, except for some rather small areas of retreat along the peripheries. The unoccupied land adjacent to the railroads in Cochrane is either a timber concession of a large paper company and therefore not open to settlement, such as the area between the village of Cochrane and the Quebec border, or the land is physically unfit for settlement, as is the case between Matheson and Timmins. By 1931, settlement in Abitibi had spread several miles deep along either side of the railroad from the Ontario border to Senneterre, the present eastern margin of agricultural settlement. The several finger-like northward and southward projections from the main

[6] A. Marwick, *Northland Post* (Oshawa, Ontario, The Maracle Printing Company, 1950), p. 129.

[7] G. R. Ouellet, *L' Abitibi* (Quebec: Ministère de la Colonisation, 1952), pp. 31 and 59.

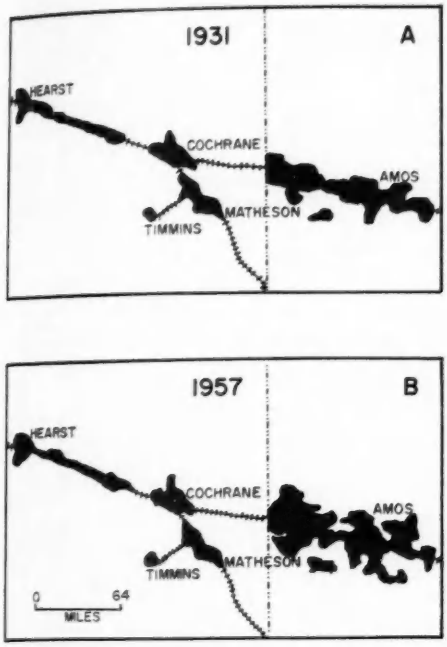

FIG. 4. The Spread of Settlement in the Great Clay Belt, 1931–1957. (Sources: *Census of Canada, Population*; and field observations.)

axis of settlement became enlarged by the establishment of twenty-eight new parishes in the quarter-century following 1931 (Fig. 4B).

The railroads have set the major axis of the settlement pattern, but the types of land survey have determined its detailed alignments. The differences inherent in the three types of survey used in the Great Clay Belt account for the details of the pattern of rural population distribution and, in part, for the local density (Fig. 5). In the southern part of Cochrane County, the townships are six miles square and consist of thirty-six one-square-mile sections. Each section is surveyed into four parcels of approximately one hundred and sixty acres each. In the northern part of Cochrane County, including the area of settlement from the village of Cochrane to Hearst, the townships are nine miles square. This system of survey has contributed to the wider dispersion of rural population, for neighboring farms are seldom closer than one-quarter mile and frequently as much as four miles of forest, swamp or brush separates adjacent farms. Widespread farm

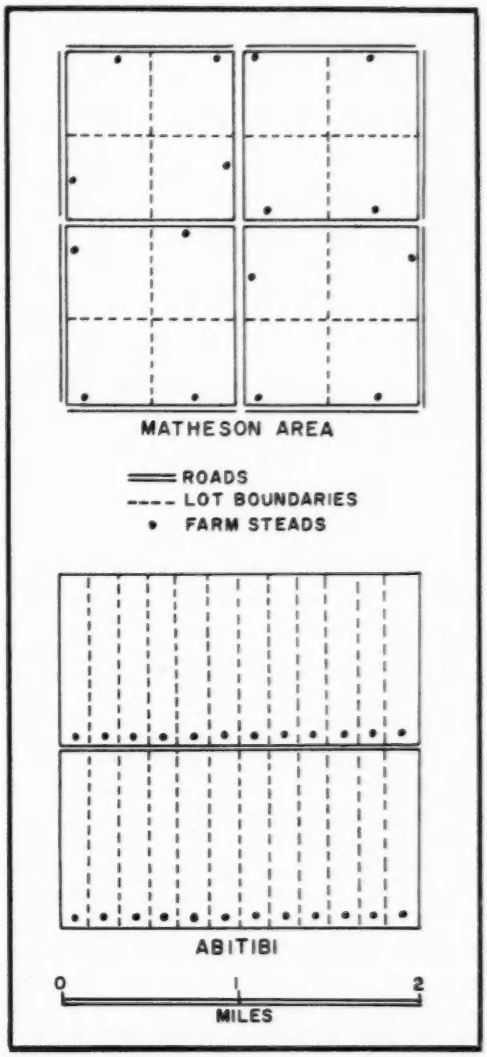

FIG. 5. Influence of different survey systems on patterns of rural settlement.

abandonment has led to even wider dispersion of rural population in Cochrane County.

The land survey system used in Abitibi has laid the framework for a pattern of rural population distribution that contrasts sharply with that of Cochrane. The ten-mile-square townships are surveyed into ranges one mile wide that extend east–west at two-mile intervals and the individual farm lots are one mile deep north–south with approximately 880 feet front-

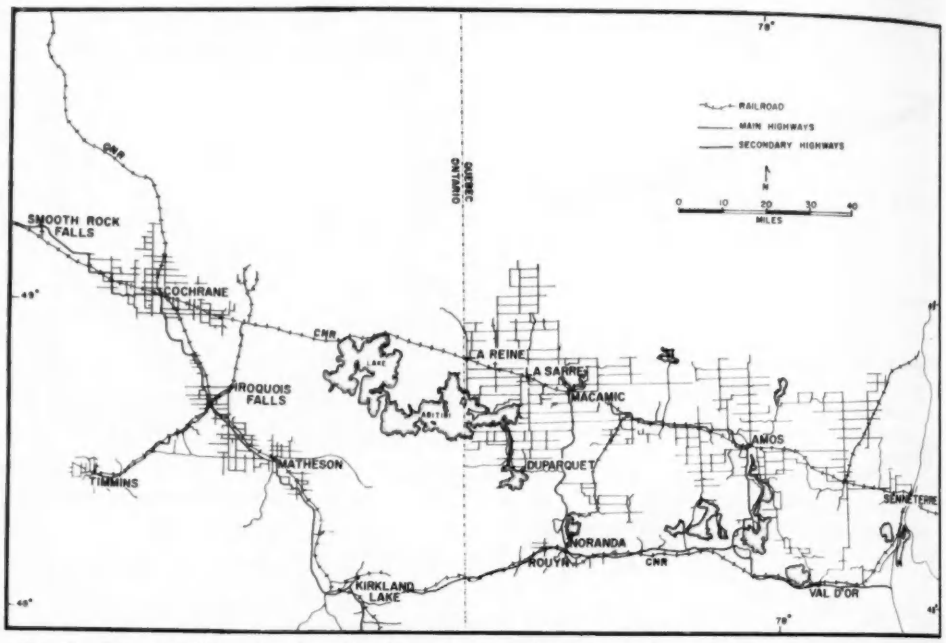

FIG. 6. Transportation network and major agglomerated settlements in part of the Great Clay Belt. The towns of Timmins, Kirkland Lake, Rouyn-Noranda, Duparquet, and Val d'Or, whose combined population exceeds 104,000, are mining centers on the southern margin of, or peripheral to, the Clay Belt. Pulpmills are located in Iroquois Falls, Smooth Rock Falls, and Kapuskasing (see Fig. 9).

age on the road (Fig. 5). Farm houses are so closely spaced that Randall has compared the settlement along a range road to the *strassendorf* development.[8] Although the settlement pattern is linear along any one of the east-west roads, the gross pattern is more compact and less ribbon-like than in Cochrane (Fig. 6).

Both Cochrane and Abitibi were opened for settlement about 1910, and until 1931, the farm population, the number of farms, the amount of land in farms, and the amount of improved land on farms remained about the same for each county. A quarter of a century later the contrasts between Cochrane and Abitibi in these four areas is indeed striking (Figs. 7 and 8). During this period, Abitibi's farm population more than tripled, while Cochrane's rose to a peak in 1941, then declined again to about the 1931 level (Fig. 7A). The total number of farms increased more than two and one-half times in Abitibi, but decreased by one-third in Cochrane (Fig. 8A). As the number of farms increased in Abitibi, the amount of land in farms increased proportionately, and as the number of farms declined in Cochrane, the amount of land in farms decreased over 24 percent, in contrast to an increase of 224 percent in Abitibi. Between 1951 and 1956, the amount of improved land in Cochrane declined over 8,000 acres, while during the same period Abitibi's improved land increased more than 39,000 acres (Fig. 8B).[9]

The decrease in farm population and the number of farms in Cochrane is not a cause for alarm, for such decreases have occurred over most of the United States and Canada during the last half-century. However, unlike most of Canada, the amount of land in farms in Cochrane has also decreased (Fig. 7B).[10] This is of

[8] J. R. Randall, "Settlement of the Great Clay Belt of Northern Ontario and Quebec," *Bulletin of the Geographical Society of Philadelphia*, Vol. 36 (1939), p. 58.

[9] All statistical data are from the *Census of Canada, Agriculture*, 1931, 1951, and 1956.

[10] Since 1931, Canada's farm land has increased by eleven million acres, although there has been some decrease in the Maritime Provinces and in small areas of other provinces. Since 1951, the total land in farms in Abitibi has also declined slightly.

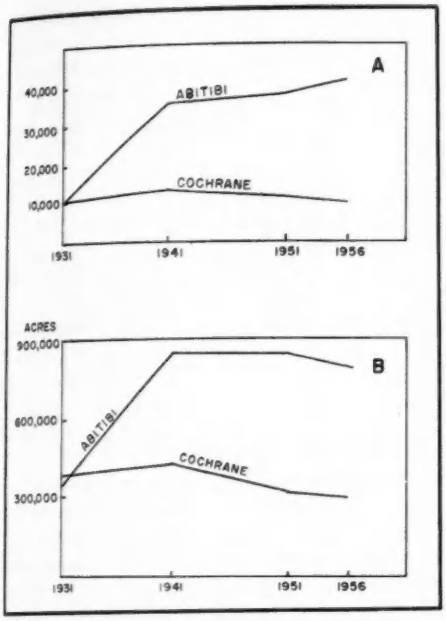

FIG. 7. A = farm population, B = land in farms. (Source: *Census of Canada, Agriculture.*)

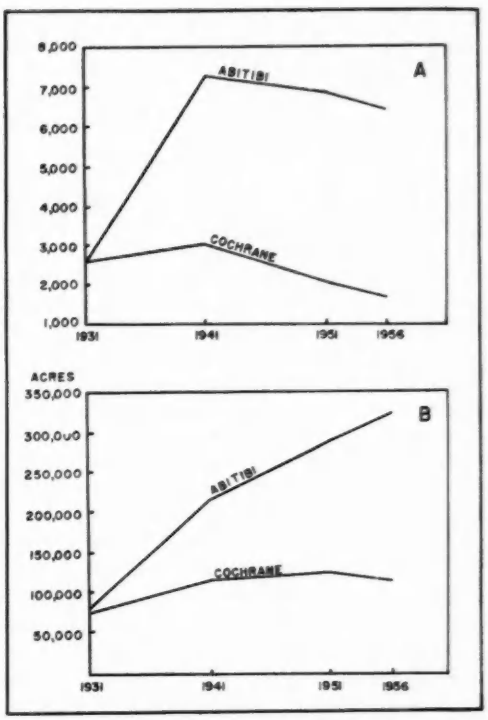

FIG. 8. A = number of farms, B = improved land on farms. (Source: *Census of Canada, Agriculture.*)

particular significance, for little of the abandoned land has been absorbed into the remaining farms, as has been the case in most other areas in Canada. Thus, in Cochrane the withdrawal of people from the frontier has resulted in the complete abandonment of farm land.

Analysis of the census statistics reveals that settlement has been advancing in Abitibi and at the same time retreating in Cochrane. The censuses, however, do not give data for units small enough to permit accurate mapping of areas of advance and retreat within each county. Extensive field work was required to determine where the frontier had advanced and retreated in the quarter-century prior to 1957.

THE RETREATING FRONTIER

The abandonment of land, ostensibly taken up for agriculture, has been one of the major problems associated with the settlement of the Ontario Clay Belt. Inasmuch as some abandonment took place very early in the history of settlement, it is necessary to distinguish between abandonment that occurred prior to and since 1931, the beginning date for this study.[11] Only those abandoned lots with standing buildings or evidences of former buildings were mapped, for on these lots the settler had made an attempt to comply with the agricultural settlement duties which required the construction of a habitable house.[12]

[11] The method used for dating abandonment was, in the absence of records, subjective. In each major area of settlement, dates of abandonment of specific properties were determined through interview, then notations were made on the size and kind of natural vegetation that had encroached upon the cleared land. Then comparison was made with the vegetation on the lot whose date of abandonment was not known. Actually most abandoned lots could be clearly classified in one category or another and very few arbitrary decisions were necessary. However, this method is subject to numerous errors, not the least of which are differential growths of vegetation due to slight differences of soil, differences in individual plants, and the condition of the land when abandoned.

[12] This distinction was made because many of the "timber pirates" lived in tents or in town while they stripped the timber from their lots.

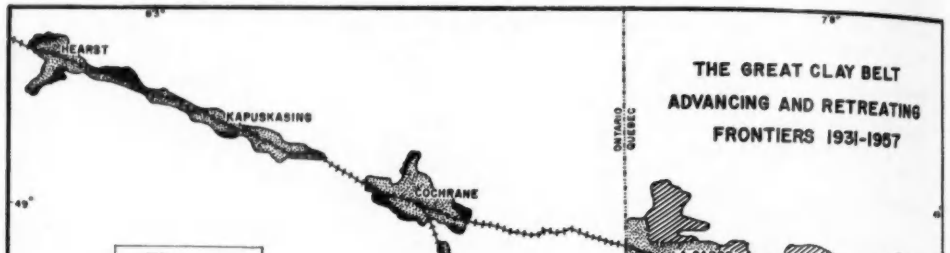

FIG. 9. Advancing and retreating frontiers of settlement, 1931–1957.

Although farm abandonment is rather widespread throughout the Great Clay Belt, it is much more concentrated in Cochrane than in Abitibi. One very striking difference in the pattern of abandonment occurs between Cochrane and Abitibi; in Abitibi the abandoned farms are scattered throughout the settled areas, and although the same is true in Cochrane, there is a marked concentration of abandonment at the ends of the roads and along the peripheral roads in the nodes of settlement, such as around the villages of Cochrane and Matheson. In Cochrane many abandoned farms are several hundred yards removed from the nearest road, but in Abitibi the abandonment is adjacent to the roads, for the settlers were permitted to buy land only along existing roads.[13]

In spite of government inducements to the French-Canadians to settle in Abitibi, about two-thirds of the rural population in Cochrane County is French.[14] Comparison of the number of French and English householders served by thirty-four rural post offices in Cochrane County for the years 1931 and 1956 reveals that English Canadians account for over 70 percent of the total decline.[15] Inasmuch as the post offices serving the villages, pulp mill towns and the mining settlements were excluded from this comparison, it can be safely asserted that the English and other non-French-Canadians have accounted for the greatest proportion of the farm abandonments.

There are relatively few areas of settlement in Cochrane larger than two square miles where some abandonment has not occurred since 1931. Only three areas are outstanding for their relative lack of abandonment: (1) Montjoy Township northwest of Timmins, (2) the area immediately northeast of the village of Cochrane, and (3) the area west of the Cochrane-Matheson road in the vicinity of Iroquois Falls.

A retreating frontier is defined, for the purposes of this study, as an area in which more than 60 percent of the farms are abandoned and the land is not used by neighboring farmers. Empirical evidence indicates that where 60 percent of the farms are abandoned, the whole landscape takes on a derelict, reverting-to-nature appearance and agricultural operations are minimal. In the areas of retreat, many of the occupied farms are on the brink of abandonment and the care of a garden or a cow is the extent of the settlers' agricultural endeavor.

[13] Interview with Clovis Meloncon, Chief of Pre-Settlement Survey and Parish Planning, Department of Colonization, June 25, 1957.

[14] *Number of Householders Served from Rural Post Offices and Rural Routes in the Province of Ontario* (Public Relations Division, Post Office Department, April 1956), pp. 10 and 55.

[15] *Ibid.*, and personal communication with W. M. Griffiths, Director of Comptroller's Branch of Post Office Department, on the 1931 data.

Eleven areas have a sufficiently high percentage of abandonment to be classed as a retreating frontier. In Cochrane, they are: (1) northeast of Matheson, 75 percent, (2) west of Matheson, 62 percent, (3) southeast of Cochrane, 80 percent, (4) east of Cochrane, 70 percent, (5) northwest of Cochrane, 66 percent, (6) southwest of Cochrane, 63 percent, (7) south of Kapuskasing, 81 percent, (8) east of Hearst, 91 percent, (9) northwest of Hearst, 80 percent, and (10) south of Hearst, 67 percent. Only one area of concentrated abandonment was found in Abitibi, a rather small area on the southern fringe of settlement twenty miles south of La Sarre, 77 percent (Fig. 9). Actually, overall land abandonment is somewhat higher than these figures indicate for they are for the period since 1931 and some land abandonment took place before that date.

The overall distribution of retreat forms a spotty pattern peripheral to existing settlement and removed from the main east-west highway and railroad. On Figure 9, the areas of settlement are outlined and those that have shown no appreciable change during the period 1931–1957 are designated as "stable."

The retreating frontier displays certain observable characteristics, the combination of which aid in its identification in the field. The recently abandoned fields, guarded only by broken fences, are choked with weeds, the first echelon of the more formidable army of alder and willow, birch and poplar that will soon follow. Abandoned houses and barns in varying stages of decadence are a common sight on the retreating frontier. Many of the buildings, particularly those with glass windows, have become the prey of vandals and thus have aged prematurely. Some settlers have even left machinery standing in the fields where it was last used. A log or clapboard barn falling down around a rusting hayrake is an ephemeral monument to man's attempt, and failure, to cope with the numerous problems that beset the settler on the Clay Belt Frontier.

As man withdrew from the frontier the institutions and commercial establishments that served him also were abandoned. Unoccupied schools and churches and closed country stores are common on the retreating frontier. Although these cultural features have been slowly vanishing from the rural scene in Anglo-America since the automobile became common, in the Clay Belt their abandonment is almost exclusively confined to the zones of retreat.

The roads on the retreating frontier show few signs of use. Double-lane, graded gravel roads that are common throughout most of the Clay Belt, give way to single lane, ungraded, and often dirt-surfaced roads on the retreating frontier. Some township roads are so overgrown with grass that even the wheel tracks have been obliterated.

Also characteristic of the retreating frontier is the absence of new clearings, good pasture, and cattle on the occupied farms. Many of the occupied farms on the retreating frontier appear to be on the brink of abandonment. Those settlers who remain derive very little of their income from farming, but work at jobs elsewhere while continuing to live on their farm lot.[16] Scattered here and there on the retreating frontier are a few settlers earnestly trying to succeed at farming. However, these settlers are quite discouraged, for the value of their land declines more rapidly with each abandonment in the neighborhood than it can be increased by improvements brought about by hard labor and investment. Abandonment breeds abandonment.

In the areas where more than half of the farms are still occupied, those areas designated as the stable frontier, settlement seems to be on firmer ground (Fig. 9). On the stable frontier, most of the farms have cattle, the pastures are relatively free from brush, the fences are in good repair, some new but small clearings are observed on the back lots, and the roads are well traveled. Here, man appears to have a certain measure of control over the physical environment, whereas on the retreating frontier man's works are slowly being obliterated by nature.

THE ADVANCING FRONTIER

The advance of the frontier has received more attention in the literature than the retreating frontier, perhaps because it is more common. Certainly it is more pleasant to report on man's achievements than his defeats. In *Pio-*

[16] The major sources of farm income in the Great Clay Belt are the sale of (1) dairy products, (2) cattle, and (3) hay, in the order listed. For a detailed discussion of agriculture in the Clay Belt see John R. Randall, "Agriculture in the Great Clay Belt of Canada," *Scottish Geographical Magazine*, Vol. 56 (1940), pp. 12–28.

neer Settlement, twenty-six authors discussed the problems attendant upon the advance of settlement in seventeen of the world's major frontier areas.[17] In few, if any, of these regions have the principles of scientific settlement advocated by Bowman,[18] been so vigorously applied as in the Quebec portion of the Great Clay Belt, where the frontier has advanced with remarkable rapidity during the last quarter of a century.

An advancing frontier is defined, for the purposes of this study, as an area in which the farms have been established since 1931, and in which more than 60 percent of the total number of farms is occupied. Data on the dates of establishment were obtained from old maps, interviews, Annual Reports of the Ontario Department of Lands and Forests, the Quebec Ministry of Colonization, and from parish histories.

The gross distributional pattern of advance, as well as retreat is clearly divided along provincial boundaries (Fig. 9). All the areas of advancing frontier are in Abitibi and are larger in extent than the areas of the retreating frontier in Cochrane. This is congruent with the census data which indicate great growth in Abitibi and modest decline in Cochrane (Figs. 7 and 8).

In detail, the distribution of areas of advance is peripheral to the older established areas of settlement. Inasmuch as the land adjacent to the railroad and main east-west highway was settled quite early, the advancing frontier is several miles, in some places more than thirty miles, removed from the main axis of settlement. The advance of the frontier has taken the form of broad, finger-like projections into the forest both northward and southward from the railroad. Some of these areas, particularly those southwest, south, southeast, and northeast of La Sarre, are individual parishes, while each of the other areas of advance consists of three to six contiguous parishes.

Although small, ephemeral advances of the frontier were made in Cochrane—especially west of Matheson, southwest of the village of Cochrane, and south of Hearst—by the Relief Land Settlers during the early 1930's, nearly complete abandonment of these areas has subsequently occurred. Thus, no area larger than a few widely scattered individual farms has advanced the frontier in Cochrane during the last quarter of a century. Not only did the frontier in Cochrane fail to advance during this period, but it also failed to maintain the limits once established.

The advancing frontier may be identified in the field by the combination of several observable characteristics. The most striking features are the new, small clearings flanked by forest on one, two, or three sides. The land, newly exposed to sunlight, is covered with a reddish brown peat which has a raw, cold appearance, and when plowed becomes mottled as the peat and gray clay are interwoven.

In Abitibi, the newness and style of the homes and farm buildings are indicative of the advancing frontier. In the four parishes established since the Second World War, the houses are characteristically square, one and a half stories high and covered with red or blue asphalt shingle siding. These houses were built according to specifications of the Quebec Ministry of Colonization and are identical in every outward detail. Houses built prior to the Second World War are quite varied in style, although some form of the two-story type prevails. There is an obvious lack of such refinements as surfaced driveways, sidewalks, lawns, flowers, and general landscaping around the houses.

Because the Province of Quebec has given substantial financial aid to each new parish for the construction of a central school and parish church, these buildings are more permanent and more attractive than those commonly found on the advancing frontier in the Prairie Provinces.[19] The amount of landscaping is frequently the only observable difference in the exterior appearance of the churches and schools in the stable areas and on the advancing frontiers.

Three mechanical symbols of the advancing frontier have recently appeared in Abitibi: (1) the bulldozer which is used to remove tree

[17] W. L. G. Joerg (ed.), *Pioneer Settlement* (New York: American Geographical Society, Special Publication No. 14, 1932).

[18] Bowman, *op. cit.*

[19] C. A. Dawson, *Settlement of The Peace River Country*, Vol. 9 of *Canadian Frontiers of Settlement*, (Toronto: Macmillan, 1934), p. 9. For a more recent discussion see Burke G. Vanderhill, "Observations in the Pioneer Fringe of Western Canada," *Journal of Geography*, Vol. 57 (1958), pp. 431–441.

stumps after the merchantable timber has been cut, (2) the giant plow, pulled by a twenty-four-ton caterpillar-type tractor, which penetrates the soil to a depth of three feet or more, and (3) the power shovel which is used to excavate deep ditches to drain marshy land. These three government-owned implements have done much to hasten the process of establishing farms, and in many instances have rendered fit for cultivation land that was too poorly drained or too thickly covered with peat to be utilized under previous land-breaking techniques.

Great mounds of brush and peat in the fields are no longer symbolic of the advancing frontier in Abitibi, for the use of deep plows permits the turning under of small saplings and branches, up to four inches in diameter, and several inches of peat, thus obviating the necessity of piling peat and stacking brush to be burned. As a result, the incidence of forest fires in Abitibi is much less than in Cochrane where brush burning is still common.[20]

The roadsides in front of the newly established settler's homes give testimony of the changing landscape, for they are lined on either side with shoulder-high stacks of pulpwood logs. Yet, despite the settler's valiant efforts to make farms from forests, the process is a slow one; the clearings will remain small (Fig. 2) and logs will line the roadsides for many years. Forest dominates the landscape on both the retreating and advancing frontiers. On the retreating frontier, fields are giving way to brush and forest, while on the advancing frontier the forest is giving way to fields.

CAUSES OF RETREAT

A large number of the people who attempted to settle in the Ontario Clay Belt had neither experience in or familiarity with forestry or agriculture. The settlers' unfamiliarity with the conditions of the Clay Belt as well as the techniques of their newly adopted means of livelihood caused discouragement and ultimate abandonment. For example, the settlers who were sent to Cochrane County under the Relief Land Settlement Plan in 1932 and 1933 were skilled and semi-skilled tradesmen from southern Ontario cities.[21] In the Kapuskasing and Hearst area 70 percent of the relief settlers had abandoned their lots within seven years.[22] By 1957, eight of the original 124 relief settlers in the Matheson area remained on the land, but only two were attempting to farm.[23] The zone of retreat west of Matheson was formerly occupied by these relief settlers (Fig. 9). Only two of the original 93 relief settlers who took up lots southwest of the village of Cochrane remained in 1957.[24] The 105 relief settlers in the Kapuskasing-Hearst area had also dwindled to only two by 1957.[25] These settlers originally occupied the area of retreat south of Kapuskasing and south of Hearst (Fig. 9).

Frontier settlement in the mid-twentieth century is more subject to human failure than a century ago, for the gap between life on the frontier and life in urban communities or well-established farming districts is far greater than at any time in the past. Careful screening of the settlers would help to reduce suffering and the misuse of land due to the presence of misfits on the frontier. Settler-screening programs have been employed in Quebec[26] and Argentina[27] for several years, and officials express general satisfaction with the criteria used, which include the following: the prospective settlers must have (1) experience in or aptitude for farming, (2) enough capital or equipment to begin modest farming operations (in Quebec, the government gives this kind of aid to the settler), and (3) a good reputation and be in good health. It would be to the advantage of the settler and the government alike if only those persons who have the greatest possibilities for success were permitted to purchase a lot on the frontier.

In order for an Ontario settler to obtain a let-

[20] Quimby Hess, "Land Use Planning and Resources Development in the Northern Region," Progress Report No. 1, mimeographed, Cochrane, Ontario, March 20, 1956, p. 30.

[21] *Report of the Minister of Lands and Forests*, Province of Ontario, 1941, p. 12.

[22] *Report of the Minister of Lands and Forests*, Province of Ontario, 1940, p. 11.

[23] Interview with L. H. Hanlan, Agricultural Representative, Matheson, July 19, 1957.

[24] Interview with Raoul Portelance, Agricultural Representative, Cochrane, July 24, 1957.

[25] Interview with T. J. Murphy, Lands Agent, Kapuskasing, July 26, 1957.

[26] Interview with Henri Fortier, Chief of the Establishment Service, Department of Colonization, Quebec, August 8, 1957.

[27] Carl C. Taylor, *Rural Life in Argentina* (Baton Rouge: Louisiana State University Press, 1948), pp. 354–355.

ter of patent or title to his land he must build a house of 320 square feet and reside in it for six months of every year; and clear and cultivate a minimum of two acres of land each year until fifteen acres are under cultivation.[28] These settlement duties, however, have not been rigidly enforced, with the result that many settlers removed the timber from their land but made little or no effort to farm.

None of the land in the Ontario Clay Belt had been surveyed prior to settlement to determine its agricultural capability.[29] The settler, after selecting a lot, is required to inspect it thoroughly and signify that the lot is 50 percent cultivable.[30] The large number of poorly drained lots taken up for farming and then abandoned, gives cause to wonder if the settler even inspected the land before the purchase was made. Binns considers a land-use capability survey an essential preliminary step to settlement.[31]

The major factor affecting the retreat of the frontier is the low financial return from the "bush farm" in comparison with other occupations. Of the scores of settlers, ex-settlers, and officials interviewed, each listed low farm income in proportion to labor expended as the principal cause of farm abandonment in both Cochrane and Abitibi. The estimated average farm income for Cochrane County in 1955 was $1,160, which was only one-third the average farm income for the Province of Ontario.[32] The median farm income in Cochrane for that year was less than $250.00. For the same year the average income of the Cochrane forestry worker was estimated to be over $4,000 or nearly four times the average farm income in the same area.[33] As the demand for newsprint has steadily risen, employment with the pulpwood companies has been extended to ten or eleven months a year, the slack period coming during the spring thaw when movement in the woods becomes difficult. During the active period, jobs usually exceed the local labor supply and in 1955, over one and a half million dollars was paid in wages to Quebec residents for working in the forests and mills of Cochrane County.[34]

A large number of settlers have given up serious attempts to farm, but still remain on the land. These settlers have at one time cleared and cultivated enough land, about fifteen acres, to obtain a patent, but now keep only a cow or two and cultivate a garden, and although they are essentially non-agricultural workers their land is classed as a farm.[35] In Cochrane County, 70 percent of the farms are classed as part-time and small scale farms with an annual farm income of less than $250.00.[36] Thus, the majority of the farmers obtain most of their income from work off the farm.

Mining as well as forestry has attracted settlers from their farms in at least two areas of the Clay Belt. Some of the settlers in the zone of retreat northeast of Matheson have gained employment in the asbestos mine eleven miles east of Matheson. The only area of retreat in Abitibi lies twenty miles south of La Sarre on the southern edge of the developed area and one mile north of the gold mines at Duparquet (Figs. 6 and 9). Here, as at Matheson, farms with considerable improved acreage have been forsaken for higher paying jobs in the mines.[37] The mines in this case have served as a magnet, not drawing farm produce from the local area as Innis suggests,[38] but rather drawing the farmer himself. Inasmuch as only three areas of agricultural settlement adjacent to mining centers were studied—the two mentioned and

[28] *Lands for Settlement*, Ontario Department of Lands and Forests, n. d., pp. 3–4.

[29] In 1960, the Ontario Department of Lands and Forests published *The Glackmeyer Report of Multiple Land-Use Planning*, which includes a detailed map of agricultural use capability of the settled area north of the village of Cochrane.

[30] *Ibid.*, p. 3.

[31] Sir Bernard O. Binns, *Land Settlement for Agriculture* (Rome: Food and Agricultural Organization of the United Nations, Development Paper No. 9, 1951), p. 3.

[32] *Economic Survey of Ontario*, Office of Provincial Economist and Bureau of Statistics and Research, Treasury Department, Province of Ontario, 1955, p. C-6.

[33] Interview with Quimby Hess, Regional Forester, Cochrane, June 18, 1955.

[34] Quimby Hess, "Progress Report No. 1," Land Use Planning and Resources Development Committee, Cochrane, March 20, 1956, p. 46.

[35] A farm is considered as any holding of three acres on which agricultural operations are carried out.

[36] *Census of Canada, Agriculture*, 1951.

[37] Interviews with André Chabot, Chief of Settler Establishment Service at La Sarre, July 12, 1957 and Gaston Lavoie, Deputy Chief of Colonization at Rouyn, July 10, 1957.

[38] Harold A. Innis, *Settlement and the Mining Frontier*, Vol. VII of *Canadian Frontiers of Settlement* (Toronto: Macmillan, 1936), p. 373.

the area near Timmins—it is difficult to draw conclusions concerning the effect of the mines on farm abandonment. However, it is significant that only the Timmins area has little abandonment while the other two areas are classed as parts of the retreating frontier. More research needs to be conducted in the Canadian Shield to test the theory that mining stabilizes agriculture.

Providing for the basic necessities of life is the fundamental problem facing the new settler during the first few years on the frontier. The gap between the economic return of the bush farm and the wages offered by other occupations is basic in explaining why three-fourths of the settlers in both Cochrane and Abitibi have found it necessary to couple farming with forestry or some other occupation, and why so many have given up farming entirely. The present part-time farming-forestry occupance of the Great Clay Belt is viewed by Ontario officials as a temporary, yet essential, phase in the sequence of occupation leading to full-time farming. Quebec officials, on the other hand, view part-time forestry as a short circuit en route to full-time farming, and an attempt is being made by financial grants and numerous services to shorten the period of dependence on part-time employment off the farm. However, it would appear that part-time farming is the final stage for many, if not most, of the present generation of settlers in both Cochrane and Abitibi.

CAUSE OF ADVANCE

For years the Province of Quebec has been faced with the problem of a rapidly growing population on a limited agricultural land base. This is particularly serious in Quebec, where both the church and state subscribe to the philosophy that large numbers of people should live on the land, and especially that those raised on farms should be encouraged to go into farming on their own. Only small parcels of land suitable for agriculture remain unoccupied in Old Quebec; and for a half-century or more fathers have had difficulty in establishing their sons on farms. As a result there has been a drift of people to the cities or to the United States. In an attempt to stem this flow, the Province of Quebec launched a colonization program in 1923[39] that has become more elaborate and generous with each passing year.

The Quebec Department of Colonization is dedicated to the task of assisting the settler in becoming established on the frontier. The government assistance is manifest in many forms, but may be discussed under three broad headings: (1) pre-settlement planning, (2) financial assistance, and (3) technical assistance.

Pre-settlement Planning

Each new Abitibi parish is carefully surveyed, mapped, and planned before the settlers arrive. Soil surveys are made lot by lot to determine the capability of the land for agriculture, and land that needs extensive improvement will be temporarily withheld from settlement and land unfit for agriculture will remain in forest.[40] Upon completion of the land capability maps, the location of roads, farm lots, houses, and the parish center is planned. The latter are centrally located and usually consist of a church, a presbytère, a general store, an elementary school, and a few houses. Compactness of settlement is desired by the Department of Colonization and this is fostered by the long lot survey (Fig. 5), and the department policy that settlers should be no more than five miles from the parish center and that every physically suitable lot should be occupied.[41]

Abitibi is perpared for a future advance of the frontier, for twenty-seven projected parishes, mostly north of the present area of settlement, have been surveyed, mapped, and planned.[42] These parishes will not be opened for settlement until all the suitable vacant lots in the older parishes have been filled, unless a large group of people wish to settle as a unit.

The settlement duties in Quebec are more demanding than those in Ontario. In order to obtain a letter of patent, the Abitibi settler must (1) clear and cultivate a minimum of three acres of new land each year so that within ten years thirty acres or 30 percent of the

[39] *Statistical Yearbook of the Province of Quebec*, 1924, p. 142.

[40] Personal communication from J. B. Pouliot, Chief of Land Classification, Department of Colonization, Quebec, March 15, 1957.

[41] Interview with Clovis Meloncon, Chief of Pre-Settlement Surveys and Parish Planning, Department of Colonization, June 25, 1957.

[42] Interview with Romeo Lalande, Deputy Minister of Colonization, Quebec, August 9, 1957.

lot is under cultivation, (2) build a habitable house at least twenty by twenty-four feet and occupy it until the letter of patent has been issued, and (3) build a barn thirty-four by thirty-two feet. The one hundred-acre lots sell for thirty cents an acre, payable in five equal payments, interest free, which are deductible from government grants.[43]

Financial Assistance

To encourage and assist the settler in establishing an economic farm unit of about thirty acres as rapidly as possible, the Quebec Department of Colonization has been paying statutory premiums for clearing and plowing since 1923. The first premiums were $4.00 an acre on the first five acres put into cultivation.[44] Since 1947, the settler has received $40.00 an acre for the first forty acres cleared and plowed.[45]

In addition to offering premiums for work performed, the Department of Colonization has initiated provincial, or participated in federal, settlement schemes. The Relief Land Settlement Plan of 1932–1934, a joint federal, provincial, and municipal project, previously described for Ontario, was responsible for the establishment of four parishes,[46] whose combined population was 3,650 in 1952.[47] Blanchard states that 28 percent of these settlers abandoned their land by the end of the second year,[48] yet there are very few unoccupied farms in these four parishes because the Department of Colonization makes every attempt to place another settler on the land as soon as an abandonment occurs. This policy protects the investment in the land and the buildings and takes advantage of any improvement made by earlier settlers.

The Vautrin Colonization Plan, in force during 1935 and 1936, aided the establishment of group settlements of more than fifty families by providing transportation for the head of the family, a small grant for home construction, and a small relief allowance during the first year. In addition the settler was entitled to clearing and plowing premiums of $10.00 per acre for the first twenty acres cleared and $10.00 per acre for the first ten acres plowed.[49] During the two years of its existence, the Vautrin Plan helped to establish fourteen parishes,[50] whose combined population in 1952 was over 7,200.[51]

In 1937, the Roger-Auger Colonization Plan, another joint federal, provincial, and municipal project, was inaugurated to help establish urban families on relief as settlers on the Abitibi frontier. Grants for living expenses and construction totaling over $1,200 were spread over a four-year period, at which time the federal and some municipal governments withdrew support, but Quebec kept the plan in force during the Second World War.[52] The six parishes[53] established under this plan had a combined population of over 3,600 in 1952.[54]

The present subsidy plan, adopted in 1947, is more generous and embraces more economic aspects of frontier settlement than the previous plans. Under this plan, the statutory premiums total $40.00 per acre for the first forty acres cleared and plowed, and in addition, a maximum of $1,050 is granted in credit for the purchase of livestock and farm equipment.[55] Thus, by the time forty acres are under cultivation, the settler will have received $2,650 in bonuses for working his own land for which he originally paid thirty cents an acre.

Other subsidies designed to increase the permanency of settlement include: $30.00 a month subsistence allowance for the first six months of settlement; a grant of $600.00 and a loan of an additional $600.00 for the construction of a house with the materials furnished at cost; up

[43] Romeo Lalande, "Settler Assistance, In View of Promoting Colonization Through Progressive and Rational Methods," 1956, Department of Colonization, Quebec, mimeographed, pp. 3 and 5.

[44] *Statistical Yearbook of the Province of Quebec*, 1924, p. 142.

[45] Lalande, *op. cit.*, p. 4.

[46] Ste. Gertrude de Villemontel, Laferte, Ste. Germaine de Palmarolle, and Roquemaure.

[47] C. R. Ouellet, *Un Royaume Vous Attend: L'Abitibi* (Quebec: Ministère de la Colonisation, 1952), pp. 56, 74, 81, and 82.

[48] Raoul Blanchard, "L'Abitibi-Temiscaminque," *Revue de Géographie Alpine*, Vol. 37 (1949), p. 490.

[49] *Statistical Yearbook of the Province of Quebec*, 1935, p. 165.

[50] Rapide Danseur, Destor, Preissac, La Corne, Vassan, Villebois, Beaucanton, Val St. Giles, St. Vital, Berry, St. Dominique du Rosarie, Lac Castagnier, Castagnier, and Rochebaucort.

[51] Compiled from Ouellet, *op. cit.*

[52] *Statistical Yearbook of the Province of Quebec*, 1944, p. 75.

[53] Val Paradis, Manneville, Champsneufs, Val Senneville, St. Edmond, and Ile Nepawa.

[54] Compiled from Ouellet, *op. cit.*

[55] Lalande, *op. cit.*, p. 4.

to $250.00 for well drilling; $75.00 for house and barn wiring; a $400.00 grant toward the construction of a barn; and $40.00 for planting a garden.[56] By the time the Abitibi settler, established since 1947, has 40 percent of his farm acreage under cultivation, he will have received a maximum of $4,345 in grants and subsidies from the Department of Colonization. Some of the subsidies are for work performed by the settler in establishing a farm on the frontier; others are direct grants in an effort to make settlement more permanent.

Since the inception of the present subsidy program in 1947, four parishes have been established,[57] which in 1952 had a combined population of approximately 2,100 on 370 lots.[58] By 1957, 18 percent of the lots in these parishes had been abandoned, and the process of land clearing and building construction seemed to be progressing at a slow rate. During this period the Department of Colonization has placed its greatest emphasis on settling vacant lots in existing parishes rather than creating new ones. Over 4,600 settlers were assigned partially improved lots in older parishes that had been vacated, or new lots that had recently become suitable for cultivation by the completion of a drainage or deep-plowing project.[59]

The four successive settlement plans that have been in operation continuously since 1932 have had a marked effect on the geography of Abitibi. Of the present sixty agricultural parishes in Abitibi, twenty-eight were established with the aid of one or more of these plans. The 1952 population of these newer parishes was more than 13,000 persons. None of the newer parishes has been disbanded.

Technical Assistance

In addition to pre-settlement planning and the granting of subsidies, the Department of Colonization provides the settler with a variety of technical assistance. After a settler has proved his good intentions to farm by clearing and breaking a portion of his land, he may request the assistance of the Department of Colonization's heavy machinery in further clearing and plowing. Approximately half of the cost of this operation is charged against the settler's premiums.[60] The advice and assistance of drainage engineers, foresters, agronomists, and building engineers is available on request. A settler within each parish, who has business ability and who has developed his own farm to a high degree, is employed to serve as an Inspector. His duties involve advising the settlers on clearing, planting, and other essentials to good farming, and keeping a record of the settlers' performance of the prescribed settlement duties as a basis for the payment of premiums.

The Catholic church also makes a significant contribution to settlement in Abitibi. The Department of Colonization depends primarily upon the priests of the Colonization Societies to handle publicity concerning settlement possibilities on the frontier and to secure recruits. The church parish, and not the township, is the effective unit of settlement. Each parish has a resident curé, who not only serves as a spiritual advisor but also as a financial and agricultural advisor. The strength and success of the parish is intimately related to the drive, enthusiasm, and skill of the parish priest.[61] Strong leadership is especially needed during the formative years of settlement.

SUMMARY

Although there are many factors involved in the movement of frontier in the Great Clay Belt, the role played by the respective provincial governments is of major importance. Ontario has followed a laissez faire policy toward the settler, who has employed the same trial and error methods characteristic of the frontier a century ago. Quebec has taken a more paternalistic approach to settlement by aiding the settler in every possible way through the application of rational principles to settlement planning and a willingness to spend any necessary amount of money with the result that the developed area of Abitibi has doubled in the last quarter of a century. In the final analysis, it appears that the government concerned must decide whether the advance of the frontier is desirable and whether it is willing to pay the price to achieve that goal.

[56] Lalande, *op. cit.*, pp. 2–4.
[57] St. Eugene, Languedoc, Guyenne, and Despinassy.
[58] Ouellet, *op. cit.*, pp. 45, 50, 59, and 79.
[59] Compiled from the *Rapport du Ministre de la Colonisation de la Province de Quebec*, for the years 1947 through 1956, except for 1951 and 1952 when comparable data were not reported.
[60] Interview with Al Leuzon, Chief of Colonization Works Service, La Sarre, Quebec, July 4, 1957.
[61] Interview with Romeo Lalande, Deputy Minister of Colonization, Quebec, August 9, 1957.

THE CHARACTER OF TOBACCO BARNS AND THEIR ROLE IN THE TOBACCO ECONOMY OF THE UNITED STATES

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THE committee that reported on settlement geography in *American Geography: Inventory and Prospect* states:

> In general, settlement geography has to do with the facilities men build in the process of occupying an area. . . . Studies of the character and distribution of specific facilities are beginning to receive more and more attention in the United States. . . . Specific settlement features, such as house types, the shapes of barns, and the distinctive structures associated with different kinds of agriculture or industry have been examined in detail.[1]

Although in a very loose sense the last sentence is true, by far the largest portion of the energies of settlement geographers in the United States has been concentrated on studies of the character and distribution of habitations, or of agglomerations of habitations and associated urban structures. Little attention has been given to the character and distribution of barns and other distinctive structures associated with different kinds of agriculture, despite the fact that in many areas such structures are an important component of the landscape.[2]

Tobacco barns provide a worth-while group of phenomena for investigation by settlement geographers. First, they are of inherent interest because they vary so greatly from one tobacco producing district to another, and form such prominent landscape features in each district. Second, these areal variations have an intimate functional relationship with important differences in the kinds of tobacco produced in the various producing districts. And third, tobacco barns may be of considerable value in providing a ready clue to the character of the entire rural economy of a tobacco producing area. Let us examine each of these points in more detail.

The name "tobacco barn" is applied to a surprising variety of structures in different parts of the United States (Fig. 1). It is used to refer to structures devoted entirely to tobacco curing; to structures used for curing tobacco but which also serve as general farm storage units; to structures with an upper portion louvered and arranged for tobacco curing but with a ground floor for stabling horses; to structures which are used to cure tobacco at one season of the year, and to provide sheltered feed yards for cattle at another; to structures which stand separate from "stripping" sheds as well as to those which have provision for "stripping" within, beneath, or in rooms attached to the building; to structures incorporated in the general cluster of farmstead buildings as well as to those set in the midst of fields or half-hidden in nearby woods; to log barns, to dilapidated sheds, and to huge structures set against a background of vast fields shaded with cheese cloth. Further differentiation is provided by regional variations in the favorite color—or the lack of it—of tobacco barns: red in Wisconsin, white in Pennsylvania, unpainted in Maryland and Tennessee, and two tone in Kentucky, where vertical ventilator boards are painted in contrast to the rest of the barn.

Despite variations in external form, however, the interiors of most tobacco barns are similar, with a lattice of tier poles on which tobacco can be hung to cure. Tobacco is attached to sticks before it is hung in the barn; because all tobacco sticks are about four and a half feet long, the barn has a basic framework of horizontal tier poles spaced four feet apart horizontally and twenty inches to five feet vertically. The lowest tier pole is six to nine feet above the barn floor. Tier poles are supported by transverse

[1] "Settlement Geography," Chapter Five of Preston E. James and Clarence F. Jones, eds., *American Geography: Inventory and Prospect* (Syracuse: Syracuse University Press, 1954), pp. 125–141.

[2] The few existing studies of the character and distinctive structures associated with different kinds of agriculture include Loyal Durand, Jr., "Dairy Barns of Southeastern Wisconsin," *Economic Geography*, Vol. 19 (1943), pp. 37–44; Glenn T. Trewartha, "Some Regional Characteristics of American Farmsteads," *Annals*, Association of American Geographers, Vol. 38 (1948), pp. 169–225; Eugene Cotton Mather and John Fraser Hart, "Fences and Farms," *Geographical Review*, Vol. 44 (1954), pp. 201–223; John F. Lounsbury, "Farmsteads in Puerto Rico and Their Interpretative Value," *Geographical Review*, Vol. 45 (1955), pp. 347–358; and Wilbur Zelinsky, "The New England Connecting Barn," *Geographical Review*, Vol. 48 (1958), pp. 540–553.

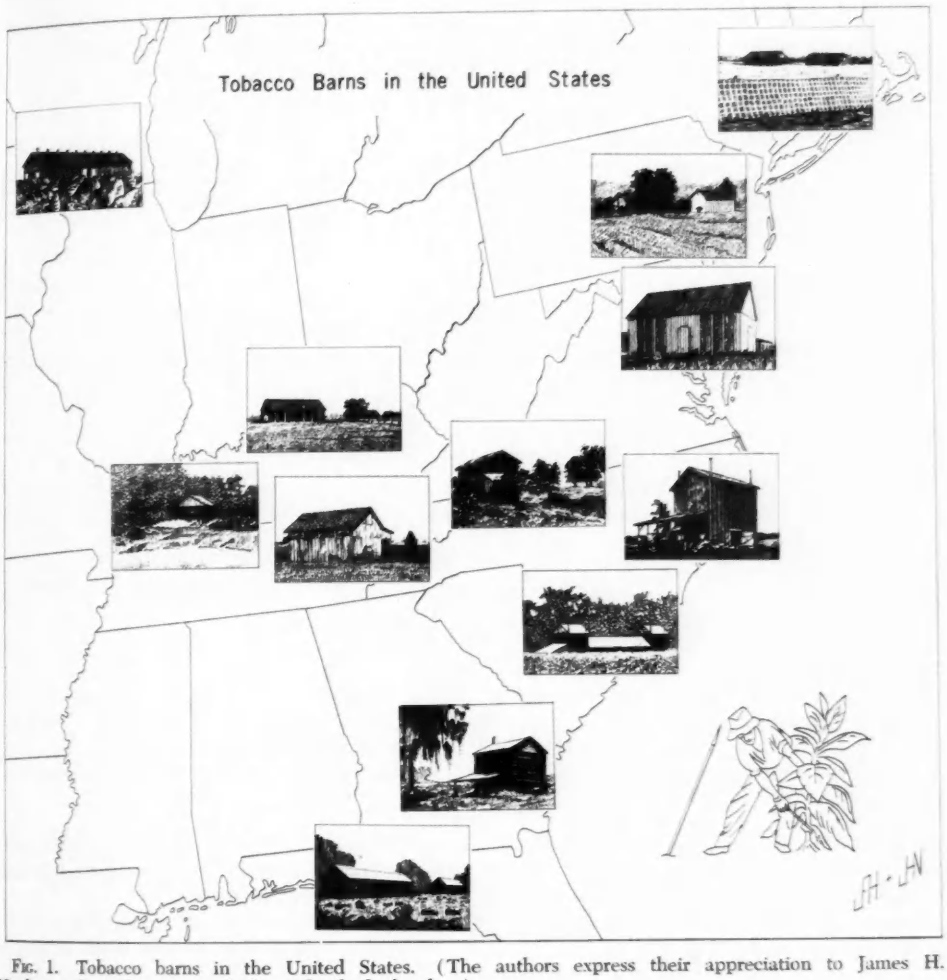

FIG. 1. Tobacco barns in the United States. (The authors express their appreciation to James H. Newberry, Jr., who prepared the individual sketches.)

lines of posts and crossbeams, and the space between transverse lines is known as a "bent." Tobacco farmers commonly think of barn size in terms of bents, and in some areas they use the rule of thumb that one bent will hang half an acre of tobacco.

Green tobacco, when it is brought into the barn, has a water content of 80 to 90 percent, and the basic purpose of the curing process is to remove this water in such a way as to facilitate those chemical changes which will produce leaf of the desired character.[3] Although the basic characteristics of the leaf have been fairly well established by the time it is harvested, the farmer can ruin a good crop by curing it improperly, and he cannot market the crop until it has been cured. In order to control the curing process, of course, he must have the right kind of barn. Areal variations in tobacco barns thus reflect, to a considerable degree, the

[3] Tobacco curing is a vital, or living, process in which the plant or leaf consumes part or all of its accumulated food reserves by respiration. The tobacco farmer regulates the complex chemical process of physiological starvation by controlling the rate of respiration and dehydration, and thus influences the chemical character of the cured leaf. Wightman W. Garner, *The Production of Tobacco*, rev. ed. (New York: Blakiston, 1951), pp. 399–400.

TABLE 1.—UNITED STATES TOBACCO: CLASSES, TYPES, AND PRINCIPAL USES

Class	Type	Principal Use
1, Flue-cured	11, Old Belt 12, New Belt 13, Carolina Border Belt 14, Georgia-Florida Belt	Cigarettes, export, pipe tobacco, plug wrapper and filler
2, Fire-cured	21, Virginia 22, Eastern 23, Western 24, Northern	Export, snuff, plug wrapper and filler, Italian-type cigars
3, Air-cured	31, Burley 32, Maryland	Cigarettes, pipe, plug Cigarettes, export
Dark Air-cured	35, One-sucker 36, Green River 37, Virginia Sun-cured	Plug, snuff, export, pipe tobacco
4, Cigar Filler	41, Pennsylvania Seedleaf 42, Gebhardt 43, Zimmer 44, Dutch 46, Puerto Rico	Cigar filler
5, Cigar Binder	51, Connecticut Broadleaf 52, Connecticut Havana Seed 53, New York and Pennsylvania Havana Seed 54, Southern Wisconsin 55, Northern Wisconsin	Cigar binder
6, Cigar Wrapper	61, Connecticut Shade 62, Georgia-Florida Shade	Cigar wrapper
7, Miscellaneous	72, Perique	Pipe tobacco

After Charles E. Gage, *American Tobacco Types, Uses, and Markets*, U. S. Department of Agriculture Circular No. 249 (Washington, rev. ed., 1942), *passim*.

localization and specialization of commercial tobacco production in this country.

Although only one single botanical species of tobacco (*Nicotiana tabacum*) is grown commercially in the United States,[4] the tobacco trade—from grower to manufacturer—recognizes some 26 different types of tobacco, as designated by the U. S. Department of Agriculture.[5] Each type is produced in a fairly well-defined area, and is especially suited to the manufacture of one or more particular tobacco products but cannot be used at all in the manufacture of others. The desirable characteristics of the leaf result primarily from the climatic and soil conditions of the producing district, but these characteristics can be enhanced by use of seed of certain varieties, by special methods of fertilization, cultivation, and harvesting, and by proper curing.[6]

For convenience, the 26 different types of tobacco are grouped into seven major classes on the basis of method of curing, method of marketing, and ultimate use (Table 1, Fig. 2).[7] The "southern" tobacco of Classes 1, 2, and 3 is grown in the former slave states of the South, is sold at auction sales in warehouses located in urban areas, and is used in the manufacture of all forms of tobacco products except cigars. It is classified on the basis of method of curing. Tobacco of Class 1 (Flue-cured Types) is hung over metal flues and cured by radiant heat

[4] *Ibid.*, p. 4.

[5] "Classification of Leaf Tobacco Covering Classes, Types, and Groups of Grades" (Washington: U. S. Department of Agriculture, Bureau of Agricultural Economics, Statistical and Regulatory Announcements, 118, 1929).

[6] Charles E. Gage, *American Tobacco Types, Uses, and Markets*, Circular No. 249 of the U. S. Department of Agriculture, rev. ed. (Washington, 1942), p. 4.

[7] Class 7, Miscellaneous Types, is not considered here because it accounts for less than 0.1 percent of national tobacco acreage and production. Some minor Types are also omitted.

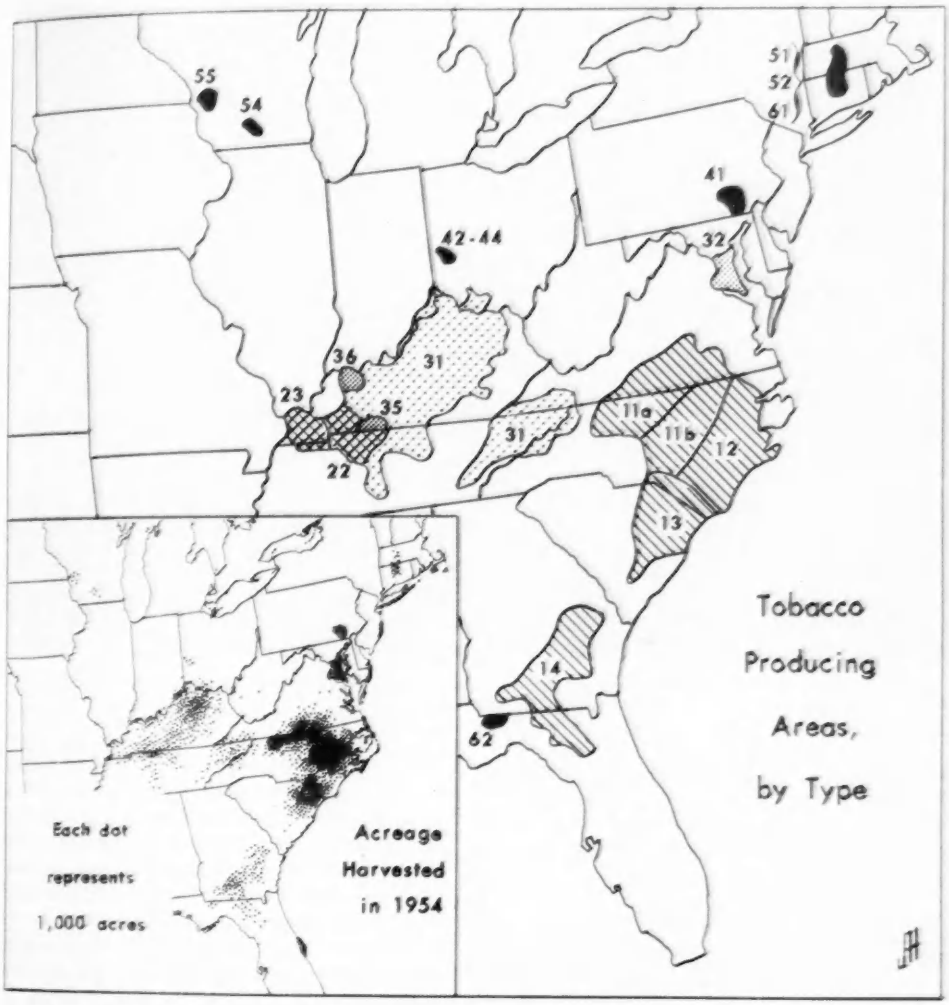

FIG. 2. Tobacco-producing areas by Type and acreage of tobacco harvested in 1954. See Table 1 for explanation of the various Type numbers. The inset map is used by courtesy of the Bureau of the Census.

which reaches temperatures as high as 180°F. Tobacco of Class 2 (Fire-cured Types) is hung over a smouldering fire of hardwood and sawdust, and absorbs a distinctive aroma from the smoke. Tobacco of Class 3 (Air-cured Types) is cured in barns with controlled ventilation, and heat plays no role in the curing process, although it may be used to control humidity in damp weather.

The "northern"[8] tobacco of Classes 4, 5, and 6 (Cigar Types) is grown mainly in the old free states of the North, is air-cured, is sold directly to buyers who visit individual farms, and is used almost exclusively in the manufacture of cigars. It is classified on the basis of its major use. Tobacco of Class 4 (Cigar Filler) is used in the core which comprises the major part of the cigar. Single leaves of tobacco of Class 5 (Cigar Binder) are bound around this core of

[8] Although this term is widely used in the tobacco trade to refer to the cigar types of tobacco, it is not precisely correct, for approximately 3 percent of the nation's cigar tobacco is produced in Gadsen County in northern Florida.

FIG. 3. Smoke pouring from a fire-cured tobacco barn. The lower structure, partly obscured by the smoke, is the stripping shed.

filler tobacco to hold it together, and single leaves of tobacco of Class 6 (Cigar Wrapper) are wrapped around the binder to form the outer wrapping which gives the cigar its characteristic appearance.

Each type of tobacco within these classes is produced in a fairly well-defined area, and each tobacco-producing area has its own characteristic and more or less distinctive kind of barn for curing tobacco. The distinctiveness of the barn may be closely related to the nature of the curing process, or it may be a product of the impact of a regional culture on a comparatively standard kind of tobacco barn. Furthermore, some areas have relict forms of tobacco barns,[9] in addition to those currently in use, for production of the different kinds of tobacco has fluctuated with changing habits of tobacco consumption.[10] Over the last century, for example, the switch from chewing to smoking has resulted in increased production of Flue-cured and Burley tobacco and an expansion of the areas within which they are produced, whereas tobacco production in other areas has declined or even disappeared (Table 3).

When its particular type of tobacco loses popularity, a tobacco producing district is seriously affected, because the crop returns such high gross income per acre that it tends to dominate the entire agricultural economy.[11] Even

[9] Cf. Loyal Durand, Jr. and Elsie Taylor Bird, "The Burley Tobacco Region of the Mountain South," *Economic Geography*, Vol. 26 (1950), pp. 274–300; ref. to pp. 281–2. In a personal communication Prof. A. J. P. McCarthy informs us that relict tobacco barns in the once important Onondaga (Type 53) tobacco district of New York are sometimes used today as corn cribs.

[10] Gage, *op. cit.* [see footnote 6, above], p. 116.

[11] If the total value of all crops sold is divided by the total acreage of cropland harvested, in 1954 farmers in the United States had a gross income of roughly $55 per acre. The national average gross income per acre for specific crops, computed in the same crude fashion, was approximately: wheat, $38; soybeans, $50; corn, $55; cotton, $115; rice, $120; vegetables, $170; fruits and nuts, $380; and tobacco, $630! For an excellent study of the effects of a drastic reduction in tobacco acreage upon an areal economy, see David L. MacFarlane, Ernest J. Nesius, Charles R. Sayre, and Robert E. Graham, "Agriculture of the Kentucky Pennyroyal Plain," *Kentucky Agriculture Experiment Station Bulletin 461* (Lexington, 1944).

though few farmers grow as much as five acres of tobacco, and many compute their allotments in terms of tenths or even hundredths of an acre, the crop provides a major share of farm income in most producing districts, especially on the smaller farms. To a certain extent, therefore, the character of tobacco barns may provide a good clue to the regional agricultural economy. Let us now examine some regional variations in the tobacco barns of the United States.

TOBACCO BARNS IN WESTERN KENTUCKY AND TENNESSEE

Western Kentucky and Tennessee have two or three different kinds of tobacco barns, because this is an area where traditional patterns of tobacco production have been most greatly modified by the "Cigarette Revolution." The oldest barns of the area most commonly are those used for fire curing. These are comparatively small, unpainted structures of frame or log, perhaps 20 to 32 feet wide and 26 to 48 feet long, but high enough for five sets of tier poles spaced three and a half feet apart. Two large doors at each end permit loaded tobacco wagons to be driven through the barn. Once the barn has been filled with tobacco, the fires of hardwood, smothered in damp sawdust, are laid right on the wagon tracks. The barn should be airtight, although few of them actually are (Fig. 3),[12] and ideally it should be located in a low place near woods for shelter and maximum heat efficiency. Although some fire-cured tobacco barns in this area are no longer used, the casual observer might overestimate the degree of abandonment, because so many barns are set back in the woods and appear relatively unkempt.

The barn used for air-curing dark tobacco is unlike the fire-cured tobacco barn and rather similar to other types of air-cured tobacco barns, albeit somewhat smaller. Low dark tobacco plants require only 1¼ to 1½ cubic feet of barn space apiece, whereas the taller Burley plant requires 2 to 2½ cubic feet,[13] and some farmers argue that a barn which holds an acre of Burley will hang three acres of dark tobacco. The barn built for air-curing dark tobacco is

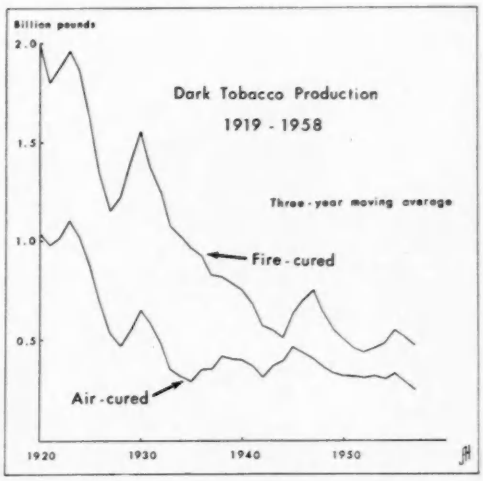

FIG. 4. Three year moving average of dark tobacco production in the United States from 1919 to 1958.

most commonly an unpainted frame structure with a 2 foot wide vertical ventilator door for each 12-foot bent. It may have a line of ventilators along the peak of the roof, and commonly has only one door in each end of the barn. It also differs from the fire-cured tobacco barn in location, for the air-cured tobacco barn is placed in the most exposed position available in order to obtain full benefit of wind from any direction.

The dark tobacco—both air and fire cured—of western Kentucky and Tennessee is closer than any other modern tobacco to the original type which was planted at Jamestown in 1612. Early settlers were producing tobacco in this area by 1800, and for more than a century it was a staple export commodity. Smoke was used in the curing process, both here and in colonial Virginia, to improve the keeping qualities of the tobacco while in transit to Europe, and this area continued to depend on the export market long after Eastern tobacco districts had turned their sights onto the domestic consumer. The world demand for dark tobacco dropped sharply in the 1920's (Table 4), however, and domestic demand for snuff and chewing tobacco—the only tobacco products in which large quantities of dark tobacco are used—has also steadily declined. As a result, production of dark tobacco has plummeted in the last forty years (Table 3, Fig. 4). In recent years dark-fired (Types 21–24) and dark air-cured (Types

[12] Most farmers in the dark-fired tobacco country have been informed at one time or another—by a panting, out-of-breath stranger—that their barns were on fire.

[13] Garner, *op. cit.*, p. 157.

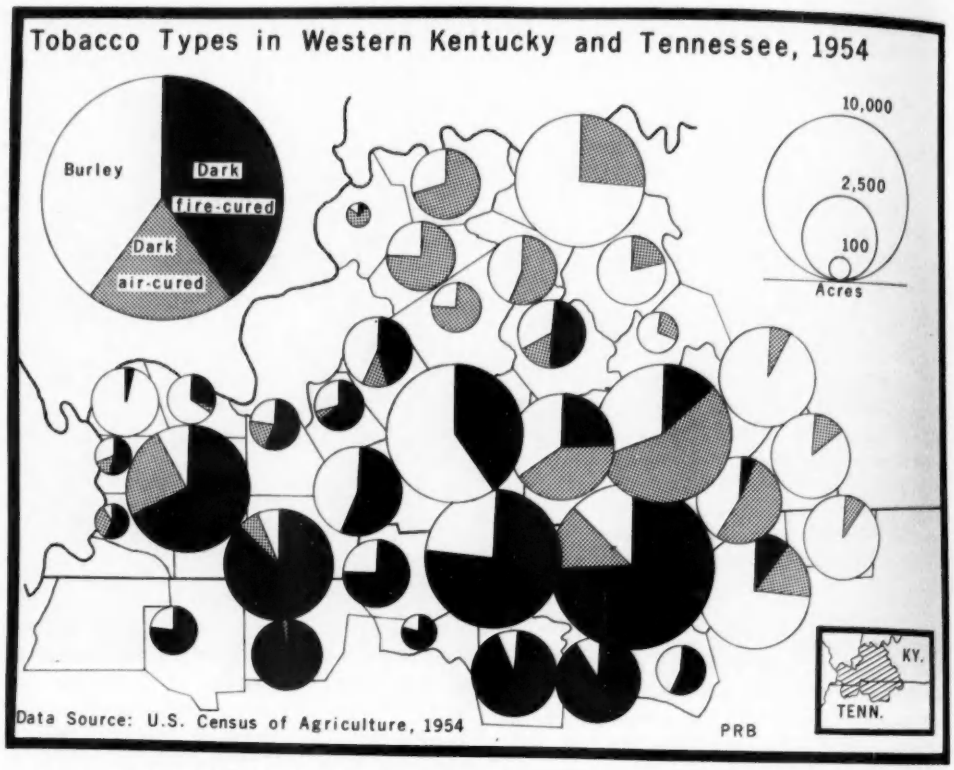

FIG. 5. The "Black Patch" of western Kentucky and Tennessee, where most of the nation's dark tobacco is grown. The circle in each county is proportional to its total tobacco acreage, and the shaded segments indicate the percentage of the acreage in each of the three main types. (The authors express their appreciation to Paul Robin Baumann for drafting this map.)

TABLE 2.—RETURNS FROM DIFFERENT TYPES OF TOBACCO (Averages for the Five Years, 1953–57)

Type	Pounds per acre	Cents per pound	Gross return per acre
11–14, Flue-cured	1,410	53.0	$ 747.30
21–23, Fire-cured	1,300	36.5	474.50
31, Burley	1,527	57.0	870.39
32, Maryland	833	48.5	404.01
35–37, Dark Air-cured	1,306	32.2	420.53
41, Pennsylvania cigar filler	1,563	24.8	397.62
51–52, Connecticut cigar binder	1,767	49.0	865.83
54–55, Wisconsin cigar binder	1,556	28.2	438.79
61, Connecticut cigar wrapper	1,258	206.0	2,591.48
62, Florida cigar wrapper	1,286	188.0	2,417.68

Source of data: U. S. Department of Agriculture, Agricultural Marketing Service, *Annual Report on Tobacco Statistics, 1958*, Statistical Bulletin No. 247 (Washington, 1959).

35–37) tobacco have had some of the lowest per acre returns of any tobacco types (Table 2).

The heart of the dark-fired tobacco country is in the western part of the two states, around Mayfield and Murray in Kentucky and Clarksville and Springfield in Tennessee (Fig. 5). Dark air-cured tobacco, which is grown between this area and the main air-cured Burley area of central Kentucky, appears to be encroaching on the dark-fired tobacco area as farmers switch to the easier curing system, and the more profitable Burley has definitely been invading areas where formerly dark air-cured tobacco was produced. A farmer who switches from dark-fired to dark air-cured tobacco often has to build a new barn, and the old one stands relict, but Burley can be cured just as easily as dark tobacco in a barn built for air-curing.

FIG. 6. A large air-cured tobacco barn, with the farmer standing in the open ventilator to give an indication of scale.

BURLEY TOBACCO BARNS

Burley tobacco barns are archetypical of air-cured tobacco barns in the United States (Fig. 6). They commonly are 28 to 40 feet wide and may be up to 300 feet long, although the majority are between 36 and 72 feet long. The height to the eaves may be anywhere from 16 to 24 feet. All sideboards are vertical, and every third board is hinged on one side so that it may be opened for ventilation. A driveway extends lengthwise through the barn, with doors at either end large enough to admit a truck or wagon loaded with tobacco. The interior framework is three or four tiers high, with tier poles four to five feet apart. The lowest tier pole is seven or eight feet high so that the tobacco hangs well clear of the ground. Although heat plays no role in the curing process, small fires may be built on the floor of the barn in damp weather to help control humidity.[14]

If possible, the barn is located on a ridge or hilltop, rather than in a valley, in order to take advantage of wind from any direction. The stripping room or shed, where cured leaf is "stripped" from the stalk (Fig. 7), is attached to the barn about midway along one side to avoid unnecessary carrying of tobacco. The stripping shed normally extends in an east-west direction so that the stripper is facing north and examining the tobacco by indirect daylight; variable cloudiness can influence his evaluation of leaf color so greatly that he dares not strip while facing the sun.

A considerable degree of variety characterizes the individual barns of the Burley tobacco-producing area, which includes large portions of Kentucky and Tennessee, and smaller areas in western North Carolina, southwestern Virginia, and southern Indiana and Ohio (Fig. 2).

[14] Lester S. O'Bannon, "Principles of Burley Tobacco Barn Operation," *Kentucky Agricultural Experiment Station Bulletin 501* (Lexington, 1947), pp. 48–61. See also his "Distribution of Temperature and Relative Humidity Within a Burley Tobacco Barn," *Kentucky Agricultural Experiment Station Bulletin 444* (Lexington, 1943).

FIG. 7. "Stripping" tobacco on temporary tables in a Kentucky Pennyroyal barn. The workers break the cured leaves from the stalk, grade them, and tie them into bundles of a single grade. Many tobacco barns have permanent stripping facilities, rather than temporary ones such as this.

The three principal areas of production center on the Bluegrass country in north-central Kentucky, the Pennyroyal[15] karst country south and east of Mammoth Cave along the Kentucky-Tennessee line, and the valleys and mountains of northeastern Tennessee. In each of these areas Burley tobacco grows best on rich silt-loam soils derived from limestone, and many tobacco farmers argue that Burley tobacco is strictly a limestone country type.

In the Kentucky Bluegrass area most tobacco barns are painted, and many have ventilators painted in contrast to the rest of the barn. Black barns with white ventilators, for instance, are common, as are white barns with green ventilators. Painted barns are indicative of the general agricultural prosperity of this area, where intensive tobacco farming is associated with extensive livestock operations. Many of the livestock farms are showplaces where fine race horses are bred, but even the fanciest horse farms have a field of tobacco and a tobacco barn tucked away at the back end of the farm where the tourist may not see them. The two operations are quite openly combined on less pretentious horse farms, and the barns are used both for curing tobacco and for stabling horses.

In the Pennyroyal karst country tobacco barns are not quite so imposing as in the Bluegrass country. Farms are smaller and less prosperous than in the Bluegrass, so there is less tobacco to be put into the barns, and less income with which to buy paint for them. Pennyroyal tobacco barns, therefore, are smaller than those of the Bluegrass, and the great majority are unpainted frame structures. Many farmers in this area manage to get along without separate stripping sheds by working on temporary tables of sawhorses and boards set up in the barn (Fig. 7).

Tobacco barns are even less impressive in the mountainous area of northeastern Tennessee

[15] To avoid the cumbersomeness of saying "Pennyroyal in Kentucky and Northern Highland Rim in Tennessee," it is suggested that the term "Pennyroyal" be considered to include those parts of the Highland Rim which lie north of the Cumberland River and the Knobs of the Nashville Basin, in addition to the traditional area in Kentucky.

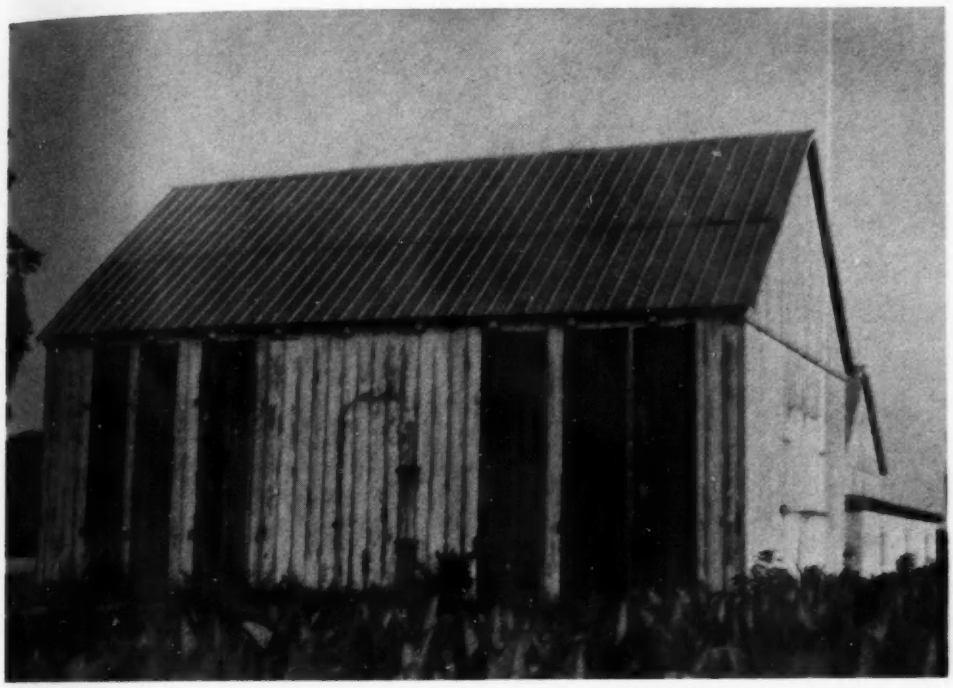

FIG. 8. Air-cured tobacco barn in southern Maryland.

and adjacent states, and there is far greater variety. Tobacco allotments in this area are quite small, averaging half an acre or less, and some tobacco fields are little more than garden patches. The farmer with an unusually large allotment might be justified in building a special tobacco barn, but on most small mountain farms the tobacco is cured in a multipurpose building which also serves other functions. Even the special tobacco barn is liable to be put to other uses out of season. In other words, a complete description of tobacco barns in the mountain Burley area would necessitate description of a multiplicity of general purpose farm buildings in a wide variety of types, sizes, and shapes, as any of these might be pressed into service for curing tobacco.

BARNS OF OTHER AIR-CURED TOBACCO AREAS

All northern, or cigar, tobacco is air-cured, as is the tobacco produced in the southern counties of Maryland (Fig. 2). The production and curing of cigar wrapper tobacco (Class 6) is so unusual that it requires separate consideration, but the tobacco barns of southern Maryland, southeastern Pennsylvania, southern Wisconsin, and the cigar binder tobacco barns of the Connecticut Valley are all fairly similar to the air-cured tobacco barns in which Burley is cured. Despite their general resemblance, however, the barns in each of these areas have certain distinctive characteristics which are more or less peculiar to the district.

In the five tobacco counties of southern Maryland, for instance, hurricanes are a potential hazard, and one Extension publication wryly notes that "evidence of poor construction, inadequate bracing, and improper anchoring to foundations are frequently seen in Southern Maryland after a windstorm."[16] The large interior spaces of tobacco barns are seldom braced, so it is necessary to brace the side walls and roof securely. The great variety of roof profiles is a striking feature of tobacco barns in southern Maryland. The majority of roofs are of the common gable type, with symmetrical

[16] O. E. Street and J. H. Hoyert, "Growing Better Maryland Tobacco," *Maryland Agricultural Experiment Station Fact Sheet 108* (College Park, 1955), p. 7.

FIG. 9. Five acre air-cured tobacco barn in southern Wisconsin.

slopes (Fig. 8), but one also finds asymmetrical gable roofs with one side steeper than the other, hip roofs, and concave upward shed roofs formed by extending a level roof outward from the bottom of a common gable roof. Although these roof variations appear designed to increase barn space, the value of additional space may be offset by the peculiar ventilation problems created.

The tobacco barn of southern Maryland is located near the tobacco field and the farmstead, and preferably on a hilltop for good ventilation and for drainage of air and water. Very few are painted. Some of the older barns are ventilated only by access doors and loose construction, but the more modern examples have vertical ventilators hinged either at the sides, or more commonly, at the top. Tobacco may be stripped in a separate building adjacent to the barn, but many farmers have built stripping rooms inside the barn itself. They find that they can retain more heat and moisture by excavating to a depth of three or four feet and constructing a semi-basement stripping room.

Virtually all of the cigar filler tobacco (Type 41) produced in southeastern Pennsylvania is grown in Lancaster County (Fig. 2). The curing barns are known locally as "sheds," despite an average size of 32 by 54 feet. The tobacco shed is part of the farmstead, in close proximity to the farmhouse and stock barns, and the majority are painted white. Although some farmers have experimented with horizontal ventilators and cupolas, the majority consider vertical ventilators more satisfactory. Every third board is hinged four-fifths of the way to the top, and it is lifted up and propped out for ventilation. Virtually all stripping is done in special stripping cellars beneath the tobacco shed. Many sheds also have an unlighted "damp cellar" in which cured tobacco can be hung to absorb enough moisture so that it will be flexible enough for stripping.

Tobacco barns are fairly standardized in the two areas of southern Wisconsin where cigar binder (Types 54 and 55) tobacco is produced. They are 28 feet wide, 15 feet to the eaves and 25 to the gable, and as long as necessary to hang all the tobacco grown on the farm. Each 14-foot bent can hold about half an acre of tobacco,

TABLE 3.—UNITED STATES TOBACCO PRODUCTION, BY TYPES: AVERAGES FOR THE PERIODS 1910–1919 AND 1953–1957

Type	Acreage				Production			
	Thousands of acres		Percentage of total		Millions of pounds		Percentage of total	
	1910–19	1953–57	1910–19	1953–57	1910–19	1953–57	1910–19	1953–57
Types 11–14	472.15	918.52	33.6	63.1	302.66	1,295.31	24.4	62.6
Types 21–24	305.42	46.48	21.7	3.2	333.23	60.41	26.9	2.9
Type 31	265.75	353.42	19.0	24.3	238.45	539.65	19.3	26.0
Type 32	26.61	44.60	1.9	3.1	19.77	37.14	1.6	1.8
Types 35–37	141.26	23.24	10.1	1.6	112.47	30.36	9.1	1.5
Type 41	42.50	28.78	3.0	2.0	55.72	44.97	4.5	2.2
Types 42–45	59.77	4.28	4.3	0.3	54.93	6.92	4.4	0.3
Types 51–52	31.00	10.80	2.2	0.7	49.21	19.08	4.0	0.9
Type 53	3.75	—	0.3	—	4.64	—	0.4	—
Types 54–55	45.00	13.44	3.2	0.9	56.93	20.92	4.6	1.0
Type 61	4.90	7.98	0.4	0.5	5.77	10.04	0.5	0.5
Type 62	3.60	4.94	0.3	0.3	4.01	6.35	0.3	0.3
TOTAL	1,401.71	1,456.80	100.0	100.0	1,237.78	2,071.14	100.0	100.0

Source of data: for 1910–1919, Gage, "American Tobacco Types, Uses, and Markets"; for 1953–1957, *Annual Report on Tobacco Statistics, 1958.*

and the capacity of the barn is readily estimated because each bent normally has a round metal roof ventilator (Fig. 9). The barn is of frame and board construction, and most commonly is painted red with white doors. The doors at each end of the barn—and in the middle of each side as well, if the barn is long enough—are large enough for a tractor and a wagon load of tobacco.

The two tobacco producing districts of southern Wisconsin have rather different kinds of barn sites. In the southern (Type 54) district, south of Madison centering on Stoughton and Edgerton (Fig. 2), the tobacco barns commonly are in or adjacent to the farmstead, and they are located with respect to the effect of topography and trees on air circulation. The northern (Type 55) district is centered near Virocqua in the Driftless Area, and here many barns are situated in valleys because there is no alternative location for the cultivated land and the farmstead. In recent years fans and heat have been extensively used in this area as aids to curing in unfavorable weather, and they have proven particularly valuable where the barn site has not provided optimum curing conditions. Extended periods of high humidity are uncommon during the curing season, however, and often the tobacco dries so rapidly that the green color remains and desired chemical changes do not occur. The danger of "haying out" is minimized by reversing the normal ventilator routine: they are opened at night and closed during the day.

Two classes of tobacco are produced in the Connecticut River Valley north of Hartford (Fig. 2). The cigar binder (Types 51 and 52) tobaccos occupy slightly more land than the more spectacular shade-grown cigar wrapper type (Table 3). The most common width of cigar binder ("field-grown") tobacco barn is 32 feet, and the normal bent is 16 feet; each bent holds approximately half an acre. Every third board is hinged, either at the sides or at the top, as a vertical ventilator, and even the gable ends of the barn have ventilators above their wide wagon doors. At one time the majority of the "field-grown" tobacco barns of this area were painted. With the rapid replacement of natural leaf binder by manufactured "homogenized" binder sheet in cigar manufacture,[17] however, and the consequent loss of income, many farmers can no longer afford to paint their tobacco barns.

Cigar binder tobacco farmers in the Connecticut Valley use more than the normal amount of

[17] Dewey estimated that an average of 21.8 million pounds a year of natural leaf binder was used in cigar manufacture in the years 1951–54, but that only 2.4 million pounds of natural leaf and 12.0 million pounds of manufactured binder sheet would be used in 1960. Arthur W. Dewey, "A Market Guide for the Cigar Binder Types of Tobacco," *Connecticut Agricultural Experiment Station Progress Report* 23 (Storrs, 1957), p. 4.

heat in curing their tobacco. The general rule of thumb in most air-cured tobacco-producing districts is to close the barn and apply heat after 24 hours of unusually humid weather in order to prevent the growth of parasitic fungi which cause a decay known as pole rot. In Connecticut, however, tobacco farmers also make a regular practice of firing their tobacco for the first two or three days it is in the barn in order to wilt it more rapidly. In other air-cured tobacco-producing districts the tobacco more commonly is allowed to wilt in the field before it is brought to the barn.

SHADE-GROWN CIGAR WRAPPER TOBACCO BARNS

Production of shade-grown cigar wrapper (Class 6) tobacco is both spectacular and expensive (Table 2). Even its history is of more than usual interest. In the last century most domestic cigars were wrapped with tobacco from the Connecticut Valley, but after 1880 the native leaf began to face serious competition from a far superior wrapper leaf imported from Sumatra. Connecticut growers obtained a protective tariff—ranging as high as two dollars a pound in 1890—against Sumatra tobacco, but they were distressed in 1896 to learn that tobacco grown in Florida under shade—to simulate the climate of Sumatra—was almost indistinguishable from Sumatra leaf. Shortly thereafter, however, one of the earliest soil surveys showed that sandy loam terrace soils of the Connecticut Valley were remarkably similar to those on which Sumatra type leaf had been grown successfully in Florida, and within half a dozen years, after intensive experimentation, the production of shade-grown cigar wrapper tobacco had become firmly established on these soils.[18]

All cigar wrapper tobacco produced in the United States is grown under cloth shades which protect the plant from direct sunlight and tend to simulate a moist tropical climate by increasing humidity and reducing evaporation and wind velocity. Specially prepared cotton cloth is sewn to galvanized wire stretched between red cedar posts set in precise 33-foot squares. The 12-foot posts are set three feet in the ground, so that the cloth is 8 to 9 feet above the surface of the field. The cloth is used on top only one year, but some of it is used a second year in double thickness on the sides. At both ends of the field the sides of the shade are arranged so that they can easily be raised for such essential operations as planting, cultivation, tying, and harvesting.

Unlike other air-cured tobacco types, shade-grown tobacco is harvested by "priming." The farmer has each individual leaf picked as it becomes ripe, rather than cutting an entire plant which has leaves in varying stages of maturity. The field is picked every week or ten days, and two to four leaves are taken each time. The primed leaves are placed in baskets and carried to the barns, where they are sewed onto sticks and hung for curing. The usual shade-grown tobacco barn is 40 feet wide, 100 to 140 feet long, and 18 to 22 feet to the eaves. The tier poles are spaced vertically at intervals of only two to two and a half feet, because only the leaf is cured. Ventilators on the side of the barn are located so as to be open between the tiers of tobacco inside and thus permit unimpeded air movement (Fig. 10). The siding of the barn is horizontal, and every third board is hinged at its upper edge to serve as a ventilator. These horizontal ventilators are attached to a vertical pole so that all may be opened or closed at one time.

Production of shade-grown tobacco in the Connecticut Valley is largely in the hands of corporations, for few individual farmers have the necessary capital. A corporation often has 50 to 60 acres of tobacco in a single field, and 15 to 20 barns may be clustered on one side to cure the tobacco from this one field (Fig. 11). Nearby is a dormitory, for much of the work in the fields and barns is done by school boys during their summer vacations. These boys come around the Fourth of July, in time to tie the plants to the overhead wires, and stay until mid-August, when most of the picking, sewing, and hanging have been completed. Many of them come from areas as far away as Pennsylvania; in the summer of 1959 they were paid a dollar an hour, plus free transportation and dormitory facilities.

Although the barns and shades are similar, production of shade-grown (Type 62) tobacco in Gadsden County near Quincy, Florida, differs in many details from production in the

[18] Clarence Irving Henderson, "An Economic Study of the Agriculture of the Connecticut Valley: 4. A History of Tobacco Production in New England," *Connecticut Agricultural Experiment Station Bulletin 174* (Storrs, 1931), pp. 33–34.

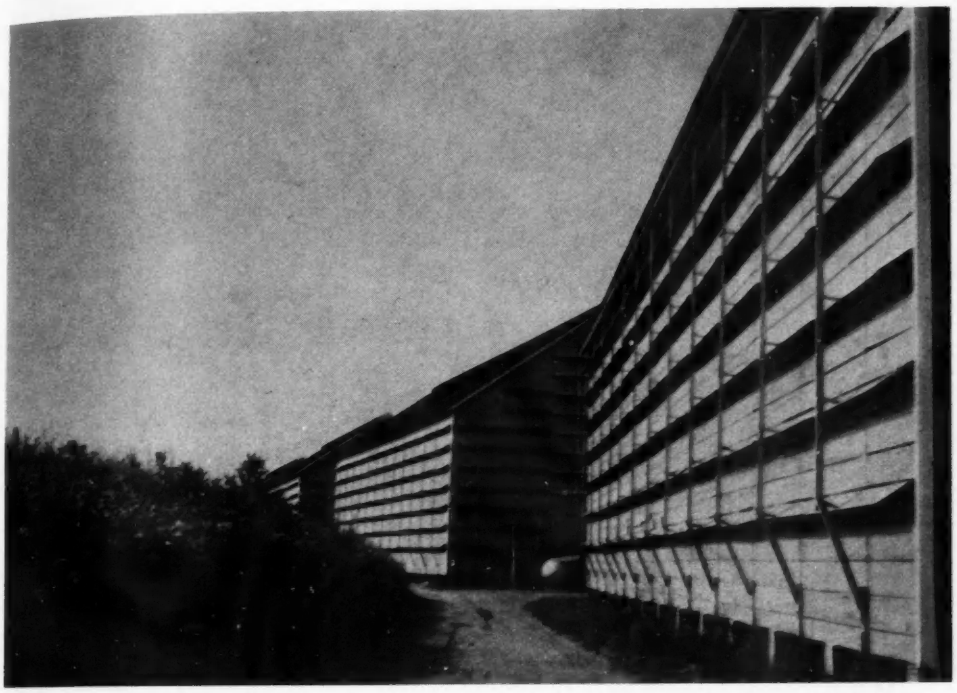

FIG. 10. Horizontal ventilators on air-cured shade-grown tobacco barns in the Connecticut Valley.

Connecticut Valley (Fig. 2). Roughly two-thirds of the Florida wrapper tobacco is produced by individual farmers, who operate on a grand scale. All labor is provided by Negroes who live through the year in houses on the farms where they work. Many tobacco barns have 3½- by 12-foot wooden "windows" rather than horizontal ventilators. These windows are hinged at the top so that they can be swung outward and upward for ventilation, and for light as well, because the tobacco barns of Gadsden County are also used as feeding barns for beef cattle.

Large-scale feeding of beef cattle, in fact, is an integral aspect of cigar wrapper tobacco production in Gadsden County, because cattle produce the manure needed to maintain soil fertility in this area. Tom Smith, one of the county's top tobacco men, comments, "I don't *mind* making money on my cattle operation, but I'm really just buying manure. This year, with cattle prices the way they are, I'm going to buy the sorriest kind of cattle you ever did see!" Although Smith's operation is rather larger than average, it illustrates the unique tobacco production system employed by tobacco farmers in Gadsden County. On five farms he grows 175 acres of shade tobacco, and needs 56 barns for the normal four-week cure; he fills a third of his barns twice in a normal year. Each barn measures approximately 42 by 120 feet, which means that his tobacco barns alone cover five and a third acres of ground!

Smith needs 800 to 1,000 feeder cattle each year to provide enough manure. He has some 400 brood cows of his own, and buys enough additional cattle each fall to satisfy his requirements. He grows 1,000 acres of corn each year for feed, and buys concentrates, cottonseed, citrus pulp, and molasses. The cattle are fed in the tobacco barns to minimize leaching of the manure. He puts about a hundred cattle in a barn, and changes the peanut hull bedding every other day (Smith grows 60 acres of peanuts). The cattle are fed out in about 120 days, and in this time each barn produces about 300 tons of manure, or enough for approximately 20 acres of land.

On his five farms Tom Smith has seventy to a hundred houses built just for tobacco work-

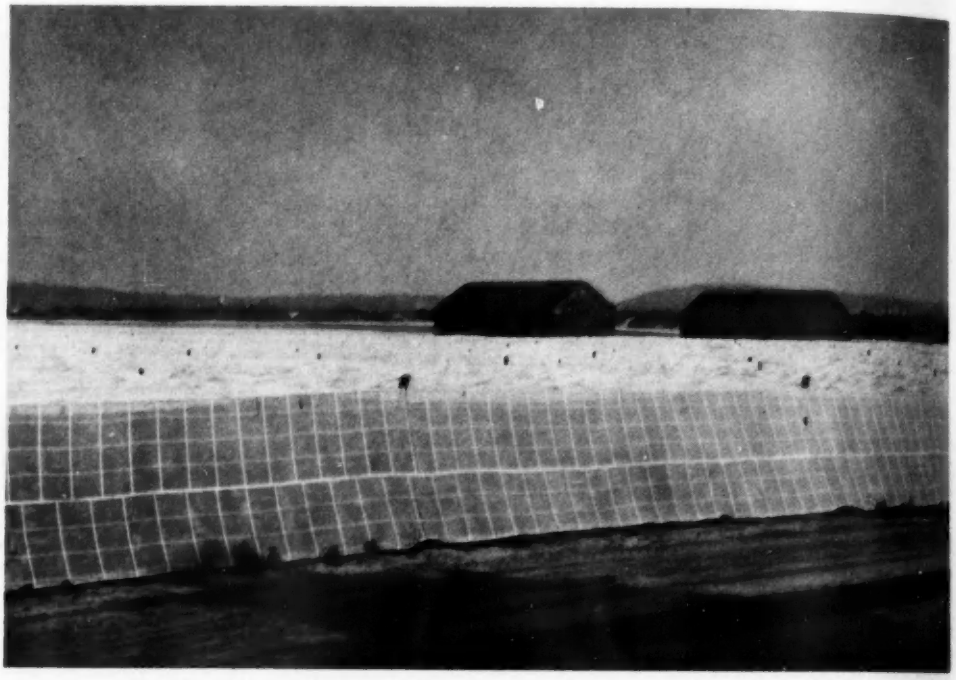

FIG. 11. Tobacco shades and air-cured tobacco barns in the Connecticut Valley.

ers. He needs six to seven hundred workers at harvest time, and around a hundred when he is sewing the cloth and making seedbeds, but only thirty at his slack season. His workers get four to five dollars a day, a free house on the farm, free truck rides to town to work in his tobacco processing plant, and free buses to town on Saturday. As he says, "People around here are just raised up in tobacco. Kids of six start toting leaves from the primers down the rows. I started getting those leaves myself when I was eight years old, and in 1937 I started tobacco farming on my own with a one-acre FFA project. Here it costs about $2,500 an acre to raise tobacco. The cloth alone costs $500 an acre, and only lasts two years. We use mules altogether, because there's no machine made that could go between those rows without hurting the tobacco. We can't match the Connecticut Valley for quality, but we moved into second place when Sumatra went out during the war. Now we export our cheapest grades to the Dutch, who spray the leaves to give them a better color and to hide their defects."

The tobacco barns of Gadsden County reflect much of the agricultural economy. They are large, averaging 42 by 120 feet, 20 feet to the eaves and 32 to the gables. Frequently a pile of peanut hulls lies close by. The barns are clustered near the farmstead, and the farmstead itself has the entire range of structures required for a large-scale cattle feeding operation: corn cribs, granaries, buildings for feed storage and mixing, machine sheds, and the like. And a little way down the road, not too far from the barns, is the row of six to eight or ten shack-like houses where the Negro workers live.

FLUE-CURED TOBACCO BARNS

Flue-cured tobacco barns are small, square, and distinctive (Fig. 12). They measure 16 to 20 (rarely 24) feet on a side, and 16 to 20 feet to the eaves, with two small access doors on opposite sides of the barn. Inside, the tier poles start about six feet above the ground, and are spaced at vertical intervals of 2 to 2½ feet, so that a barn normally contains six or seven vertical tiers. A 3-foot square brick furnace squats at one side of the barn, and from it extend two

FIG. 12. Flue-cured tobacco barn in the New Belt of eastern North Carolina. Workers under the shed are busily stringing primed leaves which have just been brought in from the field.

flues of twelve-inch sheet metal pipe which cross the barn, make two right angle bends, and emerge from the side of the barn on which the furnace is located. These flues have smokestacks to discharge gases and increase the draft.

The side of the barn with the furnace commonly has a lean-to shelter or shed to protect the furnace, the fuel supply, and the attendant. Wood formerly was the common fuel, and required a larger furnace, but today fuel oil, gas, and coal are all used. Stoker feeding and thermostatic control provide more uniform curing conditions and require less supervision. The fuel supply—and stoker, if one is used—normally are visible under the shed, which also provides shelter for stringing operations at the time of harvest.

All flue-cured tobacco is harvested by priming, or picking each leaf as it becomes ripe. The harvest is labor hungry. The field is picked about once a week for six to eight weeks, and each leaf is handled individually at least four times. Pickers walk down the rows and pull off all ripe leaves, which they place in mule-drawn sleds with waist-high burlap sides; the rows are so close together that tractors would damage the plants. Mules haul the full sleds to the shelter of the barn shed, where a "hander" picks up several leaves at a time and arranges them into a neat bunch before passing them to the "looper," or "stringer," who ties them to tobacco sticks with loops of string. The sticks are then hung in the barn for curing. Each picking is cured and taken from the barn before the next picking is made. After the leaf has been cured it must be untied from the tobacco stick and sorted into grades before it is ready for market.

A barn of flue-cured tobacco normally is cured in 3½ to 5 days. The barn is filled in a single day, and the furnace is started. In the first stage, which last 24 to 36 hours, the temperature is kept between 90°F and 100°F to change the green leaf to the desired lemon-yellow color. Then the temperature is raised to the range 130°–140°F for another 24 to 36 hours to dry the leaf before its color changes to reddish-brown, and finally the temperature is

gradually increased to 170°F or 180°F to dry the stem. The cured leaf has a bright yellow-orange color, whence the name "Bright" which is commonly applied to flue-cured tobacco.[19]

Historically, flue-cured tobacco is the product of change in the gross characteristics of the tobacco plant which occurred as "a result of the change in soil type from the heavy loams of central Virginia to the less fertile light gray soils of the North Carolina border counties."[20] Seeds of the heavy leaved, dark green plant grown in Virginia produced a plant with thin, light green leaves when grown under conditions of semi-starvation on infertile soils of the North Carolina Piedmont.[21] An even more desirable leaf was produced when semi-starvation was continued in the flue-curing process, which uses high temperatures to secure rapid dehydration and thus to inhibit metabolism in the leaf.

Flue-cured tobacco was initially used as a wrapper for plugs of chewing tobacco, because of its attractive bright color, but its real popularity has been associated with the Cigarette Revolution.[22] Although the precise blend of tobacco used in any cigarette is a closely guarded trade secret, the average cigarette probably contains 53 percent flue-cured tobacco, 33 percent Burley, 4 percent Maryland, and 10 percent oriental (from Turkey and Greece).[23] The popularity of flue-cured tobacco is indicated both by its increase from a third of the nation's tobacco acreage and a quarter of its production, in 1910–19, to more than three-fifths of both in 1953–57 (Table 3), and by its leap from less than half to more than four-fifths of the nation's exports of tobacco (Table 4).

Flue-cured tobacco was first produced along the Virginia-Carolina border in the Old Belt, where Type 11 tobacco is grown today (Fig. 2). The tobacco barns of the Old Belt are distinctly older and smaller than barns in other flue-cured tobacco districts. The great majority are constructed of horizontal logs with heavy clay chinking (Fig. 13), although a few are sheathed in tarpaper. They seldom are more than 16 feet square and 12 to 16 feet high, and the shelter frequently consists only of brush. Almost all roofs are of sheet metal, but the metal is old, rusty, and dilapidated. Oil is the most common fuel today, but it is quite a recent innovation, and most barns are located at the edge of the woods—for fuel—near the tobacco field. Jesse Tuttle, a tenant farmer near Germanton, N. C., recollects, "People used to have wood choppin's in this country. We'd cut a while and talk a while and have a *big* time. I've went to 25 different places in one year, but now that's all run out with these here chain saws."

Tuttle is representative of the hard-working, God-fearing, native white population of the Old Belt, who produce tobacco with a smaller labor force than in other flue-cured tobacco districts. He says: "I was born and raised here, and I never done anything in my life but raise tobacco, nor did my Daddy. I'll tell you

TABLE 4.—AMERICAN TOBACCO EXPORTS, BY TYPE, FOR SELECTED YEARS

Type	1923	1938	1956
	Millions of pounds		
Types 11–14	266.0	362.5	465.1
Types 21–24	194.5	56.5	30.3
Type 31	7.7	11.3	28.2
Type 32	18.1	4.5	13.5
Types 35–37	16.2	4.0	11.2
Cigar leaf	1.5	1.3	8.0
Miscellaneous*	44.9	7.9	—
Total	548.9	448.0	556.3
	Percentage of the total		
Types 11–14	48.5	80.6	83.7
Types 21–24	35.4	12.6	5.4
Type 31	1.4	2.5	5.1
Type 32	3.3	1.0	2.4
Types 35–37	3.0	0.9	2.0
Cigar leaf	0.3	0.7	1.4
Miscellaneous*	8.1	1.7	—
Total	100.0	100.0	100.0

* Including Perique, Black Fat, Water Baler, and Dark African.

Source of data: for 1923 and 1938, Gage; for 1956, *Annual Report on Tobacco Statistics, 1958.*

[19] In the export trade this tobacco is known as "Virginia," despite the fact that comparatively little of it is actually grown in Virginia (Fig. 2).

[20] W. W. Garner, H. A. Allard, and E. E. Clayton, "Superior Germ Plasm in Tobacco," pp. 785–830 of U. S. Department of Agriculture, *Yearbook of Agriculture, 1936*; ref. to p. 818.

[21] The period of expanding tobacco production in the North Carolina Piedmont witnessed "the ridiculous spectacle of a controversy between counties as to which could show the greatest area of poor land." Nannie May Tilley, *The Bright Tobacco Industry* (Chapel Hill: University of North Carolina Press, 1948), p. 135.

[22] Per capita cigarette consumption in the United States increased from one every three days in 1911 to about one a day in 1918, and nearly ten a day in 1958.

[23] Garner, *op. cit.*, p. 469.

FIG. 13. Log flue-cured tobacco barn in the Old Belt. The pile of wood on the right has been cut for fuel.

the truth, Greensboro [30 miles] and Mount Airy [31 miles] is the farthest away I ever been in my life. Last year me and them ar wimmen made 'round four acres of tobacco. I'm 68 years old, and my wife, she's 60, and my sister's 65, and my daughter, I reckon she's 'bout 38. She done finished school and she can write an awful good hand. She drives that ar tractor. We'll go out and prime half a day, and then string in the afternoon, and if we don't have enough to fill the barn we'll prime some more after we string. We always prime on Monday so's to be through on Saturday afternoon. I cured on Sunday last year, but I shouldn't ought to had, 'cause the Good Book says to keep that day holy.[24] Man grows tobacco all his life and happens to miss Heaven, he's lost it all, 'cause it takes thirteen months work a year to make a crop of tobacco. . . . Next week I'm goin' to have my tobacco sprayed by one of these here airyplanes."

From the Old Belt, production of flue-cured tobacco has expanded into new areas, mainly at the expense of cotton. In the late 1880's, for instance, when cotton prices dropped disastrously, many farmers in eastern North Carolina began to grow tobacco. They retained the traditional system of tenancy with the new crop, however, and much of the tobacco of eastern North Carolina is still produced by Negro share-croppers. Unlike the yeoman farmers of the Old Belt, the tobacco farmers of the New Belt are prodigal of manpower. A minimal harvest crew consists of four primers, four handers, two loopers, and a sled driver. Farmers in this area have expressed considerable interest in a machine harvester which, despite its almost un-

[24] Tilley cites the "serious inconvenience and loss of profit" that tobacco farmers in the Old Belt suffered through "rigid observance of the Sabbath," (Tilley, *op. cit.*, p. 59) but makes no mention of the fact that flue-cured tobacco—or any other crop—can be produced more cheaply and with a smaller labor force *if* the individual workers accept the fundamentalist religious doctrine of the value of hard work and suffering on this earth in the hope of a better life hereafter. Regional differences in religion may well be a major factor in accounting for striking contrasts in farm population density between the Old and New Belts (cf. footnote 26), just as they appear to influence migration. Cf. B. H. Luebke and John Fraser Hart, "Migration from a Southern Appalachian Community," *Land Economics*, Vol. 34 (1958), pp. 44–53; ref. to p. 49.

FIG. 14. Flue-cured tobacco barn in the Georgia-Florida Belt.

believable cumbersomeness, reduces the minimum harvest crew size from eleven workers to seven.[25] It is noteworthy that rural farm population densities in eastern North Carolina tobacco areas were the densest in the nation in 1950.[26]

The change in soils from the Piedmont to the Coastal Plain was responsible for a new type of tobacco (Type 12), which is grown in the area known as the New Belt (Fig. 2). Most of the tobacco barns of the New Belt are sheathed in insulating material covered by green or black tarpaper, which is held in place by thin vertical wooden battens nailed to the lumber of the barn (Fig. 12). Tilley considers log barns superior from the standpoint of expense and performance, and attributes the dominance of frame barns in the New Belt to the lack of suitable logs in the area.[27] These barns are 16 to 20 feet square and 18 to 20 feet high to the eaves, with metal roofs. An adjustable ventilator may run the length of the ridge line, and many barns have a smokestack jutting from each corner of the roof. Shelters are constructed on only one side, although often a shelter connects two barns. Fuel oil and gas have virtually replaced wood as fuel since 1940, but many barns are still built near the edge of the woods to reduce heat loss on windy days.

Production of flue-cured tobacco spread into South Carolina in the 1890's, again resulting in a new type (Type 13), which is produced in the area called the Carolina Border Belt, or more simply, the Border Belt (Fig. 2). The tobacco barns of the Border Belt are similar to those of the New Belt in size, shape, and general ap-

[25] W. D. Toussaint and D. G. Harwood, "Machine or Hand Harvesting Tobacco?," *North Carolina Agricultural Experiment Station Extension Circular No. 413* (Raleigh, 1957). If they prove successful, current experiments in bulk curing—which eliminates handing and stringing, and uses a smaller barn—might have important effects on the landscape and population density of flue-cured tobacco producing areas. Cf. W. H. Johnson, W. H. Henson, R. W. Watkins, and F. J. Hassler, "Bulk Curing Tobacco," *Research and Farming*, Vol. 18 (1959), pp. 4–5.

[26] In 1950 eight eastern North Carolina counties (which produced an eighth of the nation's total tobacco crop) had 49 rural farm persons per square mile, of whom 43 percent were Negroes; this is three and a half times the rural farm population density of Iowa in the same year.

[27] Tilley, *op. cit.*, p. 56.

pearance. Border Belt barns do have a greater variety of outer wall covering, with less tarpaper than in the New Belt, and more cinder block and building tile. The most striking difference, however, which may be related to slightly higher summer temperatures, is the more extensive use of shelters in the Border Belt. Whereas few barns in the New Belt have shelters on more than one side, Border Belt barns have them on two, three, or even on all four sides, and these shelters are often used for general farm storage as well as for working tobacco.

Still another pattern of shelters is found in the Georgia-Florida (Type 14) Belt, where production of flue-cured tobacco was begun in the wake of boll weevil depredations in the late 1910's (Fig. 2). More than a third of the barns in this belt have no shelters at all, and the barns that do have shelters have them on only one side. In many cases, however, the barn is adjacent to long needle pine or live oak trees, and stringing operations are conducted in the shade of the trees. (Fig. 14). Each barn has small access doors on opposite sides so that it can be loaded from the shady side. The tobacco barns of this belt are part of the farmstead, or are located close to it, and less than half are painted. Log barns are common around the fringes of the belt, although the logs are of smaller diameter than those used in the barns of the Old Belt.

Tobacco farmers in the Georgia-Florida Belt have trouble with summer droughts and with labor shortages. The first problem has largely been solved by the use of supplemental irrigation systems, and in some parts of the belt roughly three quarters of the crop receives some irrigation.[28] The labor problem is more serious, and Homer Johnson, a wool-hat farmer near Baxley, Ga., spoke for many tobacco farmers when he said: "First o' the season you round up a gang o' workers for primin', and they work for you jes' one day a week. Miss a day an' you got to wait a week! Somebody dies when you puttin' in tobacco, why you jes' let him lay there and keep puttin' it in."

FURTHER OBSERVATIONS

Our primary concern here has been the description of regional variations in tobacco barns, with some analysis of the relationship between the character of the barn, its site, and its role in the tobacco economy of the region and of the individual farm unit.[29] We have shown that both flue-cured and fire-cured tobacco barns are distinctive, and that their distinctiveness, to a large degree, is functional; they are specifically designed to cure one single class of tobacco, and cannot be used to cure tobacco of any other class. The relationship between form and function is also noteworthy in the case of air-cured tobacco barns, although it is complicated by regional variations in style which are more closely related to the culture of the region than to the function of the barn. Although our attention here has been focused almost exclusively on relationships between barn form and function, we are impressed by the influence of regional cultural variations on the character of tobacco barns, and believe that this offers a fruitful area for further investigation.

We are also impressed by the desirability of investigating the interrelations of function, culture, and form of other distinctive structures associated with different kinds of agriculture. Such studies, if pursued by reconnaissance methods at national and regional scales, would do much to broaden our comprehension of the geographic character of different areas. Our appreciation of the character of areas would be further enhanced by more intensive studies at the local level. Settlement geographers who investigate individual agriculture structures must not lose sight of the fact, however, that individual farm structures or types of structures are but components of a complex of structures which the individual farmer requires, or once required, for successful operation of his farm. While these structures may be concentrated within the farmstead, they are not exclusively so located. Like fences, tobacco barns and other man-made elements of the agricultural scene often require us to extend our attention beyond the farmstead itself. We conclude, therefore, not only with a plea for more geographic studies of individual farm structures, but with a further plea for the extension and elaboration of Trewartha's pioneer investigation of entire farmsteads.

[28] Jacksonville (Fla.) *Times-Union*, August 16, 1959.

[29] For financial assistance in support of the field work involved, the writers wish to express their appreciation to the Association of American Geographers and to the Graduate School of Indiana University. In addition, they express their gratitude for the helpful advice and suggestions of George H. T. Kimble.

RIPARIAN FORESTS OF THE SACRAMENTO VALLEY, CALIFORNIA[1]

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MODERN observers of the Sacramento Valley are struck, even dismayed, by the paucity of trees. Typically, trees are few in the open country, and appear even then only in orchards, eucalyptus plantings, occasional shelter-belts or field-side rows, around house sites, and in meager discontinuous strips along some of the watercourses. This dearth, particularly of large trees, imparts a distinctive character to the landscape and has varied consequences, not all of which are aesthetic. Unpleasant, desiccating north winds sweep virtually unobstructed over the monotonous, treeless valley floor. Livestock and humans lack shade from the powerful summer sun, and local sources of wood are scarce. But partly offsetting these and other disadvantages are, of course, some items on the credit side of the ledger, now mainly of historic importance. Pioneer settlers, for example, did not have to labor unproductively to clear wooded land for agricultural and other uses, and travel was relatively easy during much of the year.

Even so, pioneers found the region much more wooded than it is today.[2] The pristine[3] vegetation of the valley floor consisted of three major plant associations. Most extensive was the prairie, a grassland community interspersed in places with scattered valley oaks (*Quercus lobata*). The lower portions of the flood plain supported a marshgrass community, and bordering the larger streams, mainly on natural levees, were strips of woodland, sometimes several miles wide, hereinafter termed riparian forests.[4]

With the coming of the white man the pristine vegetation was modified with a rapidity and completeness matched in few parts of the United States. The change was initiated in the late Spanish and Mexican phases, and accelerated by the Anglo-American occupance.[5] The native bunchgrasses of the Sacramento Valley have been grazed out or plowed and planted to crops, and alien grasses and herbaceous plants have been introduced and widely established. The oaks that once dotted sections of the grassland have mostly disappeared, either cut down or killed at different times and places by too high water tables and saline accumulations resulting from irrigation, or lowered water tables

[1] This study was supported by a grant from the Committee on Research of the University of California, Davis. The author gratefully acknowledges helpful suggestions from Dr. Jack Major, Department of Botany, University of California, Davis.

[2] Local exceptions to this statement may be noted. There are, for instance, many artificially planted trees in the Sacramento Valley. Beside shade and ornamental trees there are almonds, apricots, citrus, English walnuts, olives, peaches, plums, prunes, and others. However, the cultivation of many of these tree crops is strongly localized, e.g., apricots around Winters, olives around Corning, peaches around Marysville, so that these plantings are only locally prominent features of the landscape.

[3] The term "pristine vegetation" is used hereinafter to designate the conditions existing at the arrival of the white man.

[4] There appears to be no accepted, and acceptable, term with which to label these forests. In geographical literature the term "gallery or *galleria* forests" is sometimes applied to the woody vegetation that prevails on stream banks in savanna and grassland country. However, the term is vaguely used and has misleading connotations. Furthermore, it lacks an established place in ecological writing. For instance, J. Richard Carpenter's *An Ecological Glossary* (New York: Hafner, reprint 1956) contains no definition of gallery forests. The term "levee forest" was considered by the author and, while appropriate for most of the wooded area under consideration, was rejected in favor of the less restrictive "riparian forest," which is here used to apply to all stream-side forest and woodland. Botanical nomenclature follows Philip A. Munz and David D. Keck, *A California Flora* (Berkeley: University of California Press, 1959), except in historical quotations.

[5] The Anglo-American period in California dates officially from the signing of the Treaty of Guadelupe Hidalgo on February 2, 1848, whereby the former Spanish colonial outpost on the Pacific passed from Mexican to United States control. However, the Spanish can hardly be said to have occupied the Sacramento Valley; they did little more than claim its sovereignty. Occupation of the area by non-Indian peoples dates from the latter part of the Mexican period (1821–48) but was largely conducted by Americans and Europeans rather than genuine Mexicans. John Augustus Sutter, the pioneer settler of the Sacramento Valley who established a large agricultural colony near the site of the city of Sacramento, was a Swiss by birth and an American by adoption although for reasons of expediency he became a Mexican citizen in 1841. The peopling of the Sacramento Valley by Anglo-American immigrants was, of course, irrevocably confirmed with the Gold Rush of 1849.

caused by flood-control measures on headstreams and local pumping. Drainage and flood control have virtually eliminated marsh vegetation from the valley. And the major continuously wooded section of the Sacramento Valley, the riparian forests of the natural levees, has been cleared with only traces remaining. Indeed, clearing of the riparian forests was one of the first of a series of actions that drastically modified the landscape during the Anglo-American period. In the author's view, the significance of the extensive riparian forests, has been very largely overlooked by students of the Sacramento Valley. Jepson, in his *Manual of the Flowering Plants of California*, speaks of the "narrow curtain of trees along the streams ... composed of *Platanus racemosa*, *Populus fremontii*, *Salix nigra* var. *vallicola*, *laevigata*, and *lasiandra* ..." but ignores their former extent, although he discusses the historical development of other life-zones.[6] Munz and Keck, in their monumental *A California Flora*, virtually ignore riparian forests and make no reference to them in their synopsis of 29 California plant communities.[7] Burcham's *California Range Land* is exceptional in noting the occurrence of extensive woodland on the Sacramento Valley floor, but his pristine vegetation map is seriously in error as far as the valley is concerned.[8]

THE SACRAMENTO RIVER AND VALLEY

The Sacramento River has its source on the slopes of Mount Eddy, in the Trinity Mountains section of the Klamath Mountains, about 6,600 feet above sea level. In its upper reaches, the river flows swiftly in a steep, narrow valley through the rugged mountains. In this section the gradient is steep, falling 5,913 feet in the first 56 miles. Then, joined by the Pit River (its principal upper tributary), the Sacramento falls 447 feet in the 67 miles to Red Bluff. Below Red Bluff the valley opens out, and nearly level lowlands border the now gently flowing river for the rest of its course. In the remaining 247 miles of its course, below Red Bluff, the river falls only 240 feet, averaging less than one foot per mile (Fig. 1).

The term Sacramento Valley may, of course, be applied in the geomorphic sense to the inclined depression bordering the entire length of the river. Local custom, however, restricts the term to the extensive lowlands bordering the river below the vicinity of Red Bluff. This lowland extends about 150 miles north-south and spreads about 45 miles east-west at its widest point, averaging about 30 miles wide. The area of the Sacramento Valley, so defined, is about 5,000 square miles; the area of the entire Sacramento River drainage basin is 26,150 square miles.[9]

The boundaries of the Sacramento Valley (in this restricted sense) are delineated fairly sharply by the Coast Ranges on the west, the Klamath Mountains on the north, and the southern Cascade Range and northern Sierra Nevada on the east. The southern margins of the valley, in contrast, are indistinct because the extremely low terrain, cut by numerous branching channels of the river, merges imperceptibly with similar terrain at the lower end of the San Joaquin River Valley. This whole low-lying and level area is formed by the combined delta (so-called, but actually a marsh-filled structural basin) of the two rivers.

The Sacramento Valley consists essentially of a level, almost featureless lowland formed by the long-continued accumulation of sediments in a great structural trough lying between the Coast Ranges and the Cascades-Sierra Nevada.[10] For a long time the trough has been

[6] Willis Linn Jepson, *A Manual of the Flowering Plants of California* (Berkeley: Associated Students Store, 1923–25), p. 6.

[7] Munz and Keck, *op. cit.*

[8] L. T. Burcham, *California Range Land* (Sacramento: Department of Natural Resources, Division of Forestry, 1957). Burcham maps a strip of marshgrass bordering the Sacramento River as far north as Glenn County, an area roughly corresponding to the natural levees. This is a topographical impossibility. The marshgrass area was actually two separate discontinuous strips some distance from the river, often several miles, in the flood basins on both sides, and in the delta. Burcham also errs in showing the "oak woodland" of the valley as forming two strips, approximately enclosing the above-mentioned marshgrass, while actually the marshgrass more or less enclosed the "oak woodland." He appears to have these two plant associations reversed.

[9] *Sacramento River Basin*, Bulletin No. 26 (Sacramento: Division of Water Resources, 1931), p. 27.

[10] The ensuing section on valley topography is based mainly on Kirk Bryan, *Geology and Ground-Water Resources of the Sacramento Valley, California*, Water-Supply Paper 495 (Washington, D.C.: Department of the Interior, 1923), and F. H. Olmstead and G. H. Davis, *Geologic Features and Ground-Water Storage Capacity of the Sacramento Valley, California* (Open-file report approved for publication as a water-supply paper, Washington, D.C.: Department of the Interior, in press).

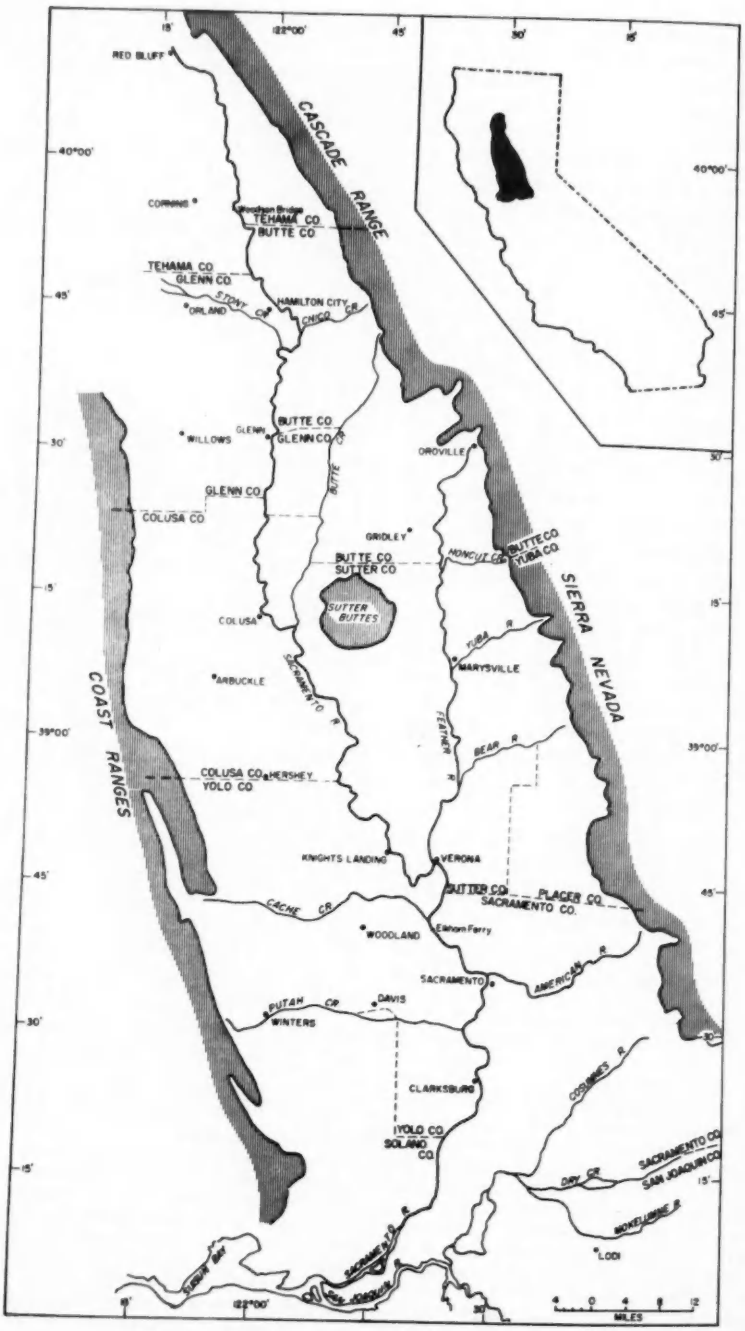

FIG. 1. Location map of the Sacramento Valley.

sinking and the enclosing mountains have been rising. Uplift of the mountains has promoted their erosion and provided much sediment for the filling of the valley. Further subsidence has lowered the valley, reduced stream gradients and encouraged alluviation. Thus the work of the river system has been, in some important respects, essentially depositional rather than erosional. A huge amount of fine material has been deeply spread over the valley floors of the Sacramento and its major tributaries—hence the flat and monotonous surface.

Although most of the surface of the Sacramento Valley is both low and level, some portions have been slightly elevated by faulting and folding, permitting stream erosion to produce slightly rolling topography. Largely from genetic considerations, Bryan recognized five natural divisions of the Sacramento Valley (Fig. 2): (1) "red lands" (above the present flood plain), (2) "river lands," (3) "flood basins," (4) "low plains," and (5) "islands."

The red lands (so-called because of iron-stained soils) consist of rolling country along both sides of the outer margins of Sacramento Valley. Formed from sediments deposited by upland tributary streams, they were originally smoothly and gently graded outward from the enclosing uplands. Uplift and faulting, however, encouraged dissection and imparted the present rolling terrain.

The low plains generally lie within, and at lower elevations than, the red lands, and have a nearly level surface, gently graded at an average rate of 5 to 10 feet per mile down to the valley floor. They have been formed of alluvium redeposited by the tributary streams engaged in dissecting the red lands. Although the low plains are characterized by extremely level alluvial surfaces, they include some irregularly deposited alluvium. Typically this is located where intermittent streams debouch from the mountains.

Another form of irregular alluviation, more or less intermediate between that of alluvial fans and true natural levees, has built up slightly elevated alluvial deposits along the lower reaches of some tributaries as they cross the low plains. These, termed channel ridges by Bryan, consist of elongated mounds that rise 10 to 25 feet above the neighboring low plains and range in width from 500 yards to 3 miles. They have been formed where tributary streams deposited part of their loads in crossing the low plains. It should be noted that the tributaries that gave rise to these irregular features, like the master streams, are now more or less subject to various flood controls and are thus no longer actively building these minor alluvial landforms.

Genetically related to the formation of channel ridges, but on a much larger scale, is the tendency of the Sacramento River and lower Feather River, like that of many other aggrading streams, to form natural levees. The greater elevation of the riparian strips can usually be seen in the field, and is quite noticeable on topographic maps with a contour interval of 5 feet. These natural levees are termed river lands by Bryan. In addition to their elevation, natural levees are differentiated from other flood plain features by the type of sediments from which they are formed. Since natural levees are built of sediments laid down by relatively fast-moving water they contain coarse-textured material. Elsewhere on the flood plain, sediments are usually deposited in slower-moving water and are thus finer-textured.

The natural levees are of relatively recent origin, and Bryan was able to state, from observations in 1912–14, that they (like the low plains) were still in process of formation. Before man's interference, the natural levees of the Sacramento rose from 5 to 20 feet above the flood basins. They range in over-all width from about 1 to 10 miles, averaging 3 miles. They are, of course, still in position, but are now generally surmounted by large artificial levees built for flood control. The enlargement and extension of artificial levees, and other flood control measures, have arrested, except very locally, the processes that formed the natural levees. Like the channel ridges, the natural levees formed corridors of generally dry land during times of flooding.

Enclosed between the natural levees and low plains is a series of very low saucer-like depressions which Bryan (following local usage) called flood basins. These are the lowest, and most nearly level, portions of the valley, and form complete, if shallow, basins without outlets. The largest of these basins are the Butte, Sutter, and American basins, on the east side of

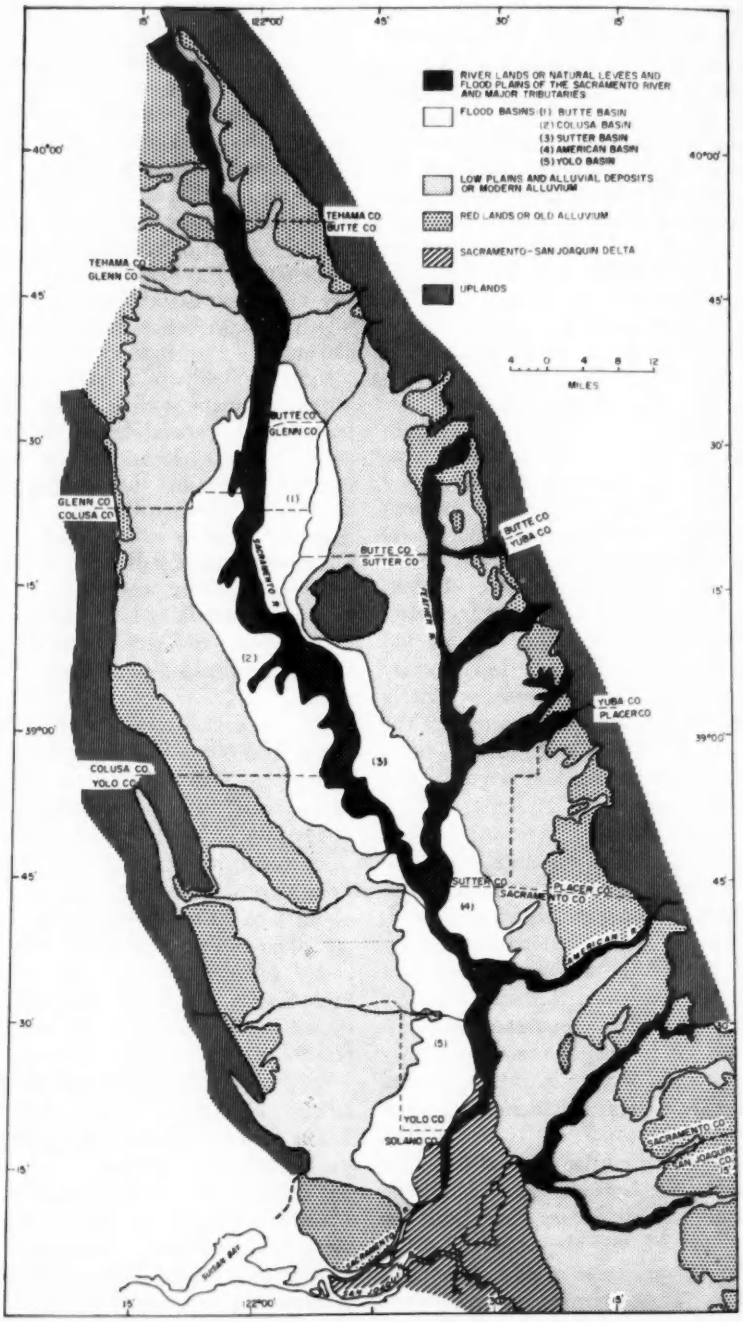

FIG. 2. Physiographic regions of the Sacramento Valley.

the Sacramento River, and the Colusa and Yolo basins, on the west side.[11]

The relatively high natural levees more or less effectively confined the main streams to their regular channels when water levels were at low or moderate stages. When winter and spring runoffs were high, however, the lower portions of the valley were below the water level of the main streams. Accordingly, in times of high water the lower portions of the flood plain, i. e., the flood basins and parts of the low plains, were converted into huge, shallow, temporary lakes. Because of the flood basins' lowness and shape, such floodwater did not readily escape but persisted for much of the year, causing a luxuriant growth of tules (*Scirpus acutus*) and other marsh plants. Because of large seasonal variation of runoff in the Sacramento River system, the extent of the inundation of flood basins and adjacent areas must have been subject to considerable annual fluctuation.

Before reclamation of the Sacramento Valley, the flood basins and low plains also received flood water from sources other than the main streams. Important among these was the upland runoff that, because of the barrier imposed by the natural levees, could not reach the main streams. In time of high runoff, water poured off the low plains in wide sheets to the low parts of the valley. Because of the lowness of the flood basins and the levee barrier, such upland runoff did not reach the main river but, spreading out from the flood basins, covered large sections of the Sacramento Valley. Since not all tributary streams could link directly with the Sacramento, they drained to the valley floor through a welter of distributaries, losing themselves "in the intricate plexus of sloughs which meander through the tule-land bordering the main river.[12] Few of the east bank tributaries, which are mainly perennial, connected through direct channels with the Sacramento River. The Feather River, for instance, is an example of a Yazoo type stream. In Ransome's words, "only the large tributaries . . . reach . . . the Sacramento by a definite channel, and often that becoming an exceedingly tortuous one."[13] As previously suggested, an additional cause of inundation of low flood plain lands was the overflowing of master streams, and the spilling of water through cracks or "crevasses" in the levees.

Below Clarksburg extends the Sacramento-San Joaquin Delta or, in Bryan's terminology, the islands. This region is cut up into numerous islands because the rivers divide into a complex arrangement of interlaced channels. These islands, of various shapes and sizes, are flat and low-lying with elevations slightly above or below sea level. Before reclamation they were submerged for much of the year, and water levels fluctuating with the tides and the flood stages of the river. The islands' outer margins generally consist of mineral deposits in the form of small natural levees, while the interior sections are composed of organic deposits formed from the tules that formerly covered the area. Most of the delta or island country is now reclaimed for cultivation under a system of artificial levees and drainage and peat is no longer formed. On the contrary, surface levels on the islands have declined since reclamation because of geologic subsidence, compaction by tillage machinery, shrinkage from drying, oxidation, burning, and wind erosion.[14]

Because of the peculiar structure of the Sacramento Valley, coupled with the sinking of the valley relative to sea level, the river system was permitted to build up a much larger area and depth of sediments than its size and age might suggest. Essentially, what happened was that the Sacramento River, below about Red Bluff, was given a very low gradient, and its capacity to carry water and transport its load was thus restricted.[15] But, more or less simultaneously,

[11] In times past, the flood basins were sometimes known as "tules" or "tulares," because of the growth of tule (*Scirpus acutus*) that filled them.

[12] F. L. Ransome, *The Great Valley of California*, University of California, Bulletin of the Department of Geology, Vol. 1, No. 14 (Berkeley: University of California, 1896), p. 379.

[13] *Ibid.*, p. 379.

[14] Walter W. Weir, "Subsidence of Peat Lands of the Sacramento-San Joaquin Delta, California," *Hilgardia*, Vol. 20 (1950), pp. 48–53.

[15] Another major determinant of a stream's discharge capacity, aside from gradient, is the cross-sectional area of the channel. During the Anglo-American period the channel size of much of the Sacramento system has undergone change. Many factors are involved, among them the deposition from hydraulic mining and the effects of flood control measures, changes in vegetation, and changes in erosional rates. However, there is some evidence that even in its pristine condition the channel of the Sacramento was imperfect and conducive to overflows. Thus, in 1880, Hall, the first state engineer, described the Sacramento channel as follows:

The river has always been one of poor regimen—great vari-

active erosion, promoted by uplift, in the mountainous sections of the river's watershed was supplying the main stream with copious quantities of sediments—which it was ill-equipped to transport. Since the runoff of the river was subject to drastic fluctuations and the river's discharge capacity was very restricted, in times of high runoff it was forced to overflow its banks. Because the river occupied a wide structural trough, the area available to receive overflow water was very considerable. Thus, extensive, nearly level alluvial deposits were built up along both sides of the master streams and the Sacramento River came to be bordered with a disproportionately low, wide, and long aggraded plain. Other depositional features, including natural levees and channel ridges, also developed on a relatively massive scale along the watercourses.

Also conducive to flooding, and in turn to the formation of alluvial land forms and vegetational modification, is the climate of the Sacramento River Basin. For example, while much of the lowland portion of the basin receives an average of less than 20 inches per year and much of the upland receives less than 40 inches, the precipitation is strongly concentrated in a small part of the year and so has a greatly enhanced flood-causing potential. Since the precipitation and warm seasons are out of phase in California, runoff per unit of precipitation is greater than in areas of summer rainfall where evapotranspiration losses are likely to be relatively high. Furthermore, the average annual precipitation misstates the actual precipitation probability, since the average is rarely received. In short, there are drastic departures from yearly precipitation averages, and within single seasons there are tremendous variations in precipitation intensity.

Although the valley floor and lower mountain slopes are characterized by mild winter temperatures, the upland sections of the basin have lower temperatures, often below freezing. Since winter is the season of maximum precipitation and lowest temperatures in the mountain sections of the basin, it follows that much of the upland precipitation is in the form of snow. Such winter snowfall may accumulate to substantial depths. Indeed, few sections of the United States record greater snowpacks than do the western upper Sierra Nevada. In 1880 and 1890, 370 inches of snow fell near Donner Summit,[16] and in 1907 and again in 1911, 308 inches of snow were measured there.[17] Tamarack, Alpine County, in the Sierra Nevada, holds the United States record for the greatest single-season snowfall—884 inches in the winter of 1906–07. Large sections of the Sierra Nevada average over 60 inches of annual precipitation, mainly in snow.

Such massive accumulations of snow melt with the higher temperatures of spring and early summer. Miller calculates the rate of ablation at Summit to be about 0.75 inches of water per day in late April and May, when melting is most rapid.[18] The normally rapid ablation rate for the Sierra snowpack may be even more rapid in individual years, for the melting season varies from year to year. In the last week of May, 1950, when a deep snowpack lasted unusually late, ablation averaged 2.0-2.4 inches of water per day at many stations in the Castle Creek Basin.[19] Although melting of snowpacks at these rates causes substantial, and sustained runoffs, it does not usually cause the rivers to overtop their banks under the modern conditions of flood control. However, it seems clear that snowmelt was a cause of flooding before reclamation and flood control measures were initiated. Therefore, snowmelt floods must have contributed to the alluviation of the valley, including levee formation.

PRISTINE CONDITION OF THE RIPARIAN LANDS

Among the first outsiders to visit the Sacramento Valley were fur trappers of the Hudson's Bay Company in the period prior to 1814. The

ation of capacity to pass the waves of flood through its different divisions—and its channel has always had serious local defects which have acted as obstructions to the passage of ation of capacity to pass the waves of flood through its differflood-waters. Thus, for 106 miles and more above the head of Butte Slough, there is a channel of *greater grade and greater dimensions than there is below*, all the way to the mouth of the Feather River, a distance of 64½ miles. And, again, the very shallow bars known as "Six-mile," "Haycock," "Hog's-back," "Iron House," and "Newtown" shoals, do not permit the free passage of the flood waves, as do the deeper and better formed reaches of the channel above and below them.

William H. Hall, *Report of the State Engineer to the Legislature of the State of California—Session of 1880*, Part I (Sacramento: Superintendent of State Printing, 1880), p. 10.

[16] According to marks made at stations on the transcontinental railroad crossing the Sierra Nevada. *Water Resources of California*, Bulletin No. 1, p. 308.

[17] *Ibid.*, p. 308.

[18] David H. Miller, "Snow Cover and Climate in the Sierra Nevada, California," *University of California Publications in Geography*, Vol. 11 (1955), p. 26.

[19] *Ibid.*, p. 27.

Spaniard Luis Antonio Arguello investigated the valley in 1817 and again in 1821, and Jedediah Smith, in 1825, may have been the first American to reach the Sacramento River. However, it was not until the 1840's that significant outside influence was felt in the northern end of the Central Valley.

This seclusion, however, could not survive the meteoric developments of the Americanization of California.[20] After 1849 came a huge influx of population, lured by gold but often quickly to adopt other pursuits. These immigrants, mostly with rural backgrounds, could not overlook the agricultural promise of the Sacramento Valley. Heightening the attractions of the Sacramento Valley for agricultural settlement was its virtually vacant condition. Its relatively sparse and unwarlike aboriginal population, having been greatly reduced in numbers by an epidemic in the early 1830's, was unable to offer more than token resistance to the American invaders.[21]

After recognizing the promise of the Sacramento Valley, the invading Americans quickly set about its realization. To do this called for new patterns of occupance and land use; and in the initiation of these the environment was substantially modified. The agencies of change were sufficiently drastic to transform the physical, biotic, and cultural landscape. One of the very first transformations concerned the natural levees and riparian lands, which were thickly forested in their pristine condition.

Because of the brief period between initial investigation and development, little information was accumulated on the aboriginal condition of the Sacramento Valley. One of the earliest observers to report on the riparian forests was John Work, in the course of a fur-trapping expedition from his headquarters at Fort Vancouver. Writing in 1832, he described the riparian forests of the Sacramento Valley, below Red Bluff as follows:

> All the way along the river here there is a belt of woods principally oak which is surrounded by a plain with tufts of wood here & there which extend to the foot of the mountain, where the hills are again wooded.[22]

Speaking of the Sacramento River levees, along the great bend just above the mouth of the Feather River, he had this to say:

> The distance we made down the river was about 10 miles . . . a part of the way through thick woods which during the high water in the winter were overflowed.[23]

He described the riparian forests on the lower Butte Creek:

> Where we are encamped in near the mountain, the bank of the river is well wooded with oak and other trees, and though the ground is very soft it does not appear liable to be overflowed.[24]

On the way up the Feather River to near Oroville the banks were similarly described:

> . . . from the appearance of drift wood the country is liable to be overflowed during high water, though it is pretty thickly wooded with oak timber.[25]

Another early visitor to the Sacramento Valley, Captain Sir Edward Belcher, R. N., noted the profusion of oak, ash, plane, laurel, sumach (*sic*),[26] hiccory (*sic*),[27] walnut,[28] roses, wild grapes, arbutus, and other small shrubs in the vicinity of the river.[29] He described its lower course as follows:

> Having entered the Sacramento, we soon found that it increased in width as we advanced, and at our noon station of the second day was about one-third of a mile wide. The marshy land now gave way to firm ground, preserving its level in a most remarkable manner, succeeded by banks well wooded with oak, planes, ash, willow, chesnut [*sic*],[30] walnut, pop-

[20] Illustrative of the pace of these developments is the well-known fact that California legally passed from the Mexican rule to statehood in the Union in a brief period of two years, skipping the territorial stage.

[21] Cook estimates that a mortality of 75 percent occurred among the Central Valley Indians during the malaria epidemic of 1830–33. See S. F. Cook, "The Epidemic of 1830–1833 in California and Oregon," *University of California Publications in American Archaeology and Ethnology*, Vol. 43, No. 3 (1955).

[22] Alice B. Maloney (ed.), *Fur Brigade to the Bonaventura, John Work's California Expedition 1832–33 for the Hudson's Bay Company* (San Francisco: California Historical Society, 1945), p. 18.

[23] *Ibid.*, p. 57.

[24] *Ibid.*, p. 33.

[25] *Ibid.*, p. 32.

[26] Perhaps Belcher meant poison oak (*Rhus diversiloba*). Could he possibly have been referring to Tree of Heaven (*Ailanthus altissima*)? This is usually considered an introduction of the Gold Rush Chinese.

[27] Perhaps buckeye (*Aesculus californica*); hickory does not occur in California.

[28] Presumably California walnut (*Juglans californica*).

[29] Captain Sir Edward Belcher, R.N., *Narrative of a Voyage Round the World Performed in Her Majesty's Ship Sulphur During the Years 1836–1842*. Vol. 1 (London: Henry Colburn, 1843), p. 130.

[30] Again, probably buckeye.

lar, and brushwood. Wild grapes in great abundance overhung the lower trees, clustering to the river, at times completely overpowering the trees on which they climbed, and producing beautiful varieties of tint. . . . Our course lay between banks. . . . These were, for the most part, belted with willow, ash, oak, or plane [*Platanus occidentalis*],[31] which latter, of immense size, overhung the stream, without apparently a sufficient hold in the soil to support them, so much had the force of the stream denuded their roots.

Within, and at the very verge of the banks, oaks of immense size were plentiful. These appeared to form a band on each side, about three hundred yards in depth, and within (on the immense park-like extent, which we generally explored when landing for positions) they were seen to be disposed in clumps, which served to relieve the eye, wandering over what might otherwise be described as one level plain or sea of grass. Several of these oaks were examined, and some of the small felled. The two most remarkable measured respectively twenty-seven feet and nineteen feet in circumference, at three feet above ground. The latter rose perpendicularly at a [computed] height of sixty feet before expanding its branches, and was truly a noble sight.[32]

The botanist William Dunlop Brackenridge, who traveled the length of the Sacramento Valley in 1841, commented on the presence of "a fine species of Platanus of very graceful groth [*sic*]" on the upper Sacramento banks.[33] Brackenridge had the following to say of the upper Sacramento Valley (probably somewhere east of Willows), presumably referring to parts of the levees and the prairies:

. . . most of the good land was covered with stately Oaks of two different species.[34] I calculated 20 good trees to the acre.[35]

After describing a similar situation near the Feather River, and referring specifically to a levee situation, actually on the lower Feather River, he wrote:

. . . could find no good fording place [i.e., across the Feather River] & therefore kept down along its margin, near this river I saw some of the finest Oak timber observed during the whole trip through from the Columbia. . . .[36]

The pioneer Colusa County settler Justus H. Rogers, describing this area as it appeared in 1843, wrote that lower Antelope Creek

. . . presented to our view not only its well-timbered borders but expanses of fertile and grassy plains, over which roamed innumerable herds of antelope, and hence it was named for the magnificent wild creature.[37]

In 1841 Lieutenant Charles Wilkes described the Sacramento River levee forests upstream from the Sutter Buttes as follows:

The river was here only two hundred feet wide, and its banks but fifteen feet high. The trees on the shores had now become quite thick, and grew with great luxuriance; so much so, that were the sight confined to the river banks, it might be supposed that the country was one continued forest, instead of an open prairie.[38]

Sutter's colleague Heinrich Leinhard, in describing his trip of 1846 up the Sacramento River, made frequent passing references to the thickness and luxuriance of the riparian forests.[39]

In 1842 Theodore Cordua, founder of New Mecklenberg (later Marysville) described this site as follows:

The whole estate was a valley with hardly any trees. There were only a few beautiful oaks. The banks of the river were lined with oaks, alders, willows, and sycamores; here and there were arbors of wild grapes.[40]

Walter Colton, who was in California in 1846–48, commented thus on the city of Sacramento, on the banks of the river:

It is a town in the woods, with the native trees still waving over its roofs. The sails of the shipping are

[31] *Platanus racemosa.*

[32] Belcher, *op. cit.*, pp. 120–123.

[33] William Dunlop Brackenridge, "Journal of William Dunlop Brackenridge, October 1–28, 1841," *California Historical Society Quarterly*, Vol. 24 (1945), p. 329.

[34] Valley oak, *Quercus lobata*; interior live oak, *Quercus wizlizenii*; according to Alice Eastwood, "An account and list of the plants in the Brackenridge Journal," *California Historical Society Quarterly*, Vol 24 (1945), p. 341.

[35] Brackenridge, *op. cit.*, p. 329.

[36] Brackenridge, *op. cit.*, p. 330.

[37] Justus H. Rogers, *Colusa County, Its History Traced from a State of Nature through the Early Period of Settlement and Development* (Orland, California, 1891), p. 46.

[38] Lieutenant Charles Wilkes, U.S.N., *Narrative of the United States Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842*, Vol. V (Philadelphia: Lea and Blanchard, 1845), p. 187.

[39] Marguerite Eye Wilbur (trans.), *A Pioneer at Sutter's Fort, 1846–1850, The Adventures of Heinrich Leinhard* (Los Angeles: The Calafia Society, 1941).

[40] Erwin G. Gudde (trans.), "The Memoirs of Theodore Cordua, the Pioneer of New Mecklenberg in the Sacramento Valley," *California Historical Society Quarterly*, Vol. 12 (1933), p. 284.

inwoven with the masses of shade, which serve as awnings.[41]

Edwin Bryant, reporting on a tour of California in 1846–47, described a panoramic view of the Sacramento Valley thus:

> . . . the spacious valley of the Sacramento suddenly burst upon my view, at an apparent distance of fifteen miles. A broad line of timber running through the centre of the valley indicated the course of the main river, and small and fainter lines on either side of this, winding through the broad and flat plain, marked the channels of its tributaries.[42]

And further:

> It (i.e., the Sacramento River) is fringed with timber, chiefly oak and sycamore. Grape-vines and a variety of shrubbery ornament its banks, and give a most charming effect when sailing on its placid and limpid current.[43]

The investigations of Lieutenant George H. Derby, conducted in 1849, shed much light on the pristine condition of the Sacramento Valley, and particularly on the original riparian forests:

> Near its mouth [i.e., the Yuba River's] it widens to about 600 feet, the ground in the vicinity being marshy and covered with tule, and the banks difficult of access on account of the density of the alders and grape-vines with which they are lined. There are many clusters of beautiful trees—oaks, sycamores, and ash—upon its banks, but it is not thickly wooded, as is the case with the Sacramento and Feather rivers and their branches.[44]

Referring to the lower Feather River, near its junction with the Sacramento, Derby wrote of the levee thus:

> Passing the farm-house [i.e., John Augustus Sutter's Hock Farm] to the left, we now entered upon a fine, level prairie, the soil of which was of the richest description, and its surface dotted with the "long-acorn oak"[45] for a distance of two or three miles from the river.[46]

And again:

> The river [i.e., the Feather River] . . . is lined on either bank with majestic sycamores, in a fine grove of which, upon the west bank, is situated Captain Sutter's farmhouse [i.e., Hock Farm], a remarkable neat adobe building. . . .[47]

With reference to the same river, he noted that

> Its banks are thickly wooded, for some two miles in depth, throughout its entire extent, with the holly and long-acorn oaks, sycamores, beech, ash, and alder trees.[48, 49]

And:

> Its banks are heavily timbered, and some fifty feet in height, coming down abruptly to the water.[50]

The banks of Bear Creek were described as "thickly wooded toward its mouth, mostly with scrub-oak, buck-eye, and alder."[51]

Derby's report is especially valuable because it includes a map, "The Sacramento Valley from the American River to Butte Creek, September and October, 1849."[52] This shows the valley as largely treeless or at least with too few trees to justify indicating them symbolically. Large expanses of the lower valley are indicated thus: "Plains from 20 to 30 miles wide with but little vegetation or water terminated to the west by Coast Range of Mountains" (referring to the west side of the valley north of Cache Creek); "Rich Arable Soil" (the Sutter Basin); "Plains usually overflowed in Winter, fine Grazing" (the American Basin); "Plains overflowed in Winter" (the Yolo Basin). Forests are, however, shown by symbol in the form of continuous and extensive strips bordering all of the major and minor streams of the lower Sacramento River system (Fig. 3).

As the final, and most recent, major historical source of information concerning the riparian forests, we turn to the careful and professional reports of the railroad route explorations from the Sacramento Valley to the Columbia River, issued in 1855. Referring to the Sacramento Valley, the reports state that

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[41] Reverend Walter Colton, U.S.N., *The California Diary* (Oakland, California: Biobooks, 1948), p. 232.

[42] Edwin Bryant, *What I Saw in California, being the Journal of a tour by the emigrant route and south pass of the Rocky Mountains, across the continent of North America, the Great Desert basin, through California, in the years 1846, 1847* (Santa Ana: Fine Arts Press, 1936 [reprint of 1848 edition]).

[43] *Ibid.*, p. 248.

[44] Francis P. Farquhar (ed.), "The Topographical Reports of Lieutenant George H. Derby," *California Historical Society Quarterly*, Vol 11 (1932), p. 115.

[45] *Quercus lobata*.

[46] Farquhar, *op. cit.*, p. 113.

[47] *Ibid.*, pp. 112–113.

[48] Holly oak presumably means interior live oak (*Quercus wislizenii*); since no beech is found in the Sacramento Valley, Derby may have meant cottonwood (*Populus fremontii*).

[49] Farquhar, *op. cit.*, p. 116.

[50] *Ibid.*, p. 117.

[51] *Loc. cit.*

[52] *Ibid.*, facing p. 99.

> The more fertile surface is covered with a growth of wild oat, or grasses, interspersed with a great variety of flowering annuals, while the gravelly and more unproductive portions support a thinner growth of coarser plants, [*Eryngium, Hemizonia, Madaria,* &c.]. Of trees, there are none, except such as grow in narrow lines along the streams. These belts of timber are of varying breadth, from a mile or more, or wide-spreading magnificent oaks [generally *Quercus Hindsii*[53]] to a meager border of willows, poplar, or sycamore, hung with festoons of grape along the water's edge.[54]

> A luxuriant growth of wild oats covers a large portion of the valley [i.e., the Sacramento Valley], and gives it an appearance of high cultivation. Grapes, which are a natural product, are also one of the very important staples of the region. The forest trees, which, in the valley, are confined to the banks of streams, are chiefly oaks, sycamores, and cotton-woods [*sic*].[55]

> The valley [i.e., the Sacramento Valley] is destitute of trees, except upon the river banks, and is covered with a luxuriant growth of wild oats.[56]

> It [i.e., the Sacramento River] is bordered by a dense growth of willows, sycamores and oaks.[57]

Referring to the summer desiccation of the Sacramento Valley, the reports indicate that

> Vegetation, except on the banks of the streams, is in a great measure destroyed, and the foliage of the trees furnishes almost the only green upon which the eye of the traveller can rest, when wearied with the glare of the sun, reflected back from the whitened plains.[58]

> The banks of the streams are lined with belts, of greater or less width, of timber, which are composed chiefly of the long-acorned oak [*Q. Hindsii*], here exhibiting a size and beauty of form not surpassed, if equalled, by the oaks of any other part of the world. Along the water's edge, the sycamore [*P. Racemosa, Fraxinus Oregona*],[59] the cotton-wood [*P. Monilifera*][60] and two species of salix [*S. Hindsiana* and *S. lasiandra*?] are overgrown by grape vines [*Vitis Californica*] and form a screen, by which the view of the river is frequently shut out from the traveller upon its banks. At the north end of the valley, along the river, and on the hills which border it, are found many plants not met with below. Of the trees, *Q. Hindsii, Q. Garryana,* and *Q. Agrifolia*,[61] the "nut pine,"[62] and cotton-wood, were the most common.[63]

Referring to *Quercus lobata*, the Railroad Route Exploration Reports comment as follows:

> Along the streams it forms belts of timber of varying width and density, the number and size of the trees being apparently proportioned to the size of the stream and the quantity of moisture derived from it . . . The trunk is often six, seven, or even eight feet in diameter, and covered with a thick and deeply cracked but light colored bark. At the height of ten or twelve feet from the ground the trunk divides into many branches, which throw out their huge arms nearly horizontally to the distance of fifty or sixty feet on either side, the extreme branches in some cases coming quite down to the ground. Near Marysville I measured one—by no means the largest one seen—of which the trunk, three feet from the ground, was six feet in diameter; the height is estimated at seventy-five feet; the circle shaded by its branches measured one hundred and twenty-five feet in diameter.[64]

That these valley oak forests varied considerably in density is suggested by the following:

> On the banks of the Sacramento, in a few instances, I saw this oak when considerably crowded . . . but, generally, both on the hills and on the plain, it inclines to form groups, or open groves in which the trees assume the spreading form . . . .[65]

And in reference to the belt of timber bordering Cache Creek the reports state:

> This timber belt is composed of the most magnificent oaks I have ever seen. They are not crowded as in our forests, but grow scattered about in groups or singly, with open grass-covered glades between them; the trunks, often seven feet in diameter, soon divide into branches, which spread over an area of which the diameter is considerably greater than the height of the tree. There is no under growth beneath them, and as far as the eye can reach, when standing among them, an unending series of great trunks is seen rising from the lawn-like surface.[66]

The forest of the tributary streams is described in these excerpts:

> We then entered a fine oak forest, which skirted the banks of Cache creek. . . .[67]

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[53] Valley oak (*Quercus lobata*).

[54] *Reports of Explorations and Survey, to Ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War, in 1854–5, according to acts of Congress of March 3, 1853, May 31, 1854, and August 5, 1854,* United States Senate, 33d Congress, 2d Session, Ex. Doc. 78, Vol. VI, *Geological Report* (Washington, D.C., 1857), pp. 20–21.

[55] *Ibid., General Report,* p. 26.

[56] *Ibid., General Report,* p. 38.

[57] *Ibid., General Report,* p. 57.

[58] *Ibid., General Report,* p. 26.

[59] Oregon ash (*Fraxinus latifolia*).

[60] *Populus fremontii.*

[61] Probably *Quercus wislizenii.*

[62] Digger pine (*Pinus sabiniana*).

[63] *Reports of Explorations and Surveys, op. cit., Botanical Report,* pp. 14–15.

[64] *Ibid., Botanical Report,* p. 30.

[65] *Ibid., Botanical Report,* p. 30.

[66] *Ibid., Botanical Report,* p. 30.

[67] *Ibid., General Report,* p. 57.

> We followed up Feather river for about 8.5 miles, and encamped near Nicholas. The road to-day was level, and often led through noble forests of oak. There was little or no underbush, and the country resembled a grand old park in appearance .... For a few miles this morning, the road continued to be bordered by the noble oak forest. The extreme shortness of their trunks gave the trees the strange appearance of having been pressed down into the ground. On leaving the forest, we travelled over a dry, dusty plain, which continued to Marysville.[68]

> ...it [i.e., *Platanus racemosa*] is growing on the banks of Feather river, a few miles above its mouth, and situated on the alluvial bottom but some 40 feet above the stream, and a little separated from the belt of timber—principally sycamore—which line its banks. This tree had a diameter of trunk of over 6 feet, an altitude of about 100 feet, and a spread of branches nearly equal to its height, constituting one of the noblest specimens of vegetation I have ever seen.[69]

Platanus racemosa was also noted along the main river:

> We found it bordering the Sacramento river and its tributaries in all parts of the Sacramento valley, but did not meet it further north.[70]

William H. Brewer, in the early 1860's, noted riparian forest species as follows:

> A wide plain borders the river [i.e., Sacramento River] on each side. We caught distant views of the mountains, but generally we saw only the river and its banks, which were more or less covered with trees —willows, cottonwoods, oaks, and sycamores—with wild grapevines trailing from them.[71]

Most of the historical reports give no indication of the actual depth of the woodland. Where Belcher examined the lower Sacramento banks, probably the delta section, in 1837 he noted a belt of large oaks (including one with a trunk 27 feet in circumference at 3 feet above the ground) "about three hundred yards in depth."[72] John Work, in 1832, probably referring to French Camp Creek, a Sierra stream that flows to the delta, wrote: "the plain is overflowed and we had to encamp at the skirt of the woods about two miles from the river."[73] Derby's report of 1849 noted a two-mile-wide belt of woods on both sides of the lower Feather River.[74] The map accompanying this report shows forest bordering all the major and minor streams in the lower Sacramento River system (Fig. 3). Thus riparian forest seems to have bordered the entire mapped portion of the river system from the vicinity of Clarksburg in the south to Glenn in the north. These riparian forests are shown as being fairly uniform in width, about four to five miles. Derby's map also shows riparian forests along the tributary streams almost equal in width to those of the main stream, and flanking the tributaries to the edge of the valley. On the Derby map Cache and Putah creeks have forests about three miles wide, the American and Feather rivers about four miles wide (which checks with a section of his report), and Butte Creek and Yuba and Bear rivers each have levee forests about two miles wide. A note of caution should be inserted here. Derby, although a topographical engineer, performed only a reconnaissance type of survey of the valley. This being so, together with the undoubted fact that the tree symbols are intended to be approximate rather than precise, his map should not be invested with undeserved (and unintended) accuracy. However, even with these limitations the Derby map does suggest riparian forest of substantial width and continuity, and in 1849 these were, of course, still virtually in their pristine condition.

It is highly improbable that the forest belt was of uniform width along both banks of the streams. Indeed, historical accounts clearly indicate the irregular occurrence of the trees. Belcher (1837) refers to the trees as being "disposed in clumps."[75] Derby also speaks of "clusters of beautiful trees—oaks, sycamore and ash" on the banks of the Yuba River to differentiate the forests there from those of the Sacramento and Feather rivers, which were "thickly wooded."[76] Elsewhere he speaks of riparian forests along the Feather River "dotted" for two or three miles back from the river.[77]

The Railroad Reports of a few years later (1855) speak of the riparian forest as being of "varying breadth, from a mile or more ... to a

[68] *Ibid.*, *General Report*, p. 57.
[69] *Ibid.*, *Botanical Report*, p. 34.
[70] *Ibid.*, *Botantical Report*, p. 34.
[71] Francis P. Farquhar (ed.), *Up and Down California in 1860–64, The Journal of William H. Brewer* (Berkeley: University of California Press, 1940), p. 296.
[72] Belcher, *op. cit.*, p. 123.
[73] Maloney, *op. cit.*, p. 61.
[74] Farquhar, *Derby Report*, *op. cit.*, p. 116.
[75] Belcher, *op. cit.*, p. 123.
[76] Farquhar, *Derby Report*, p. 115.
[77] *Ibid.*, p. 113.

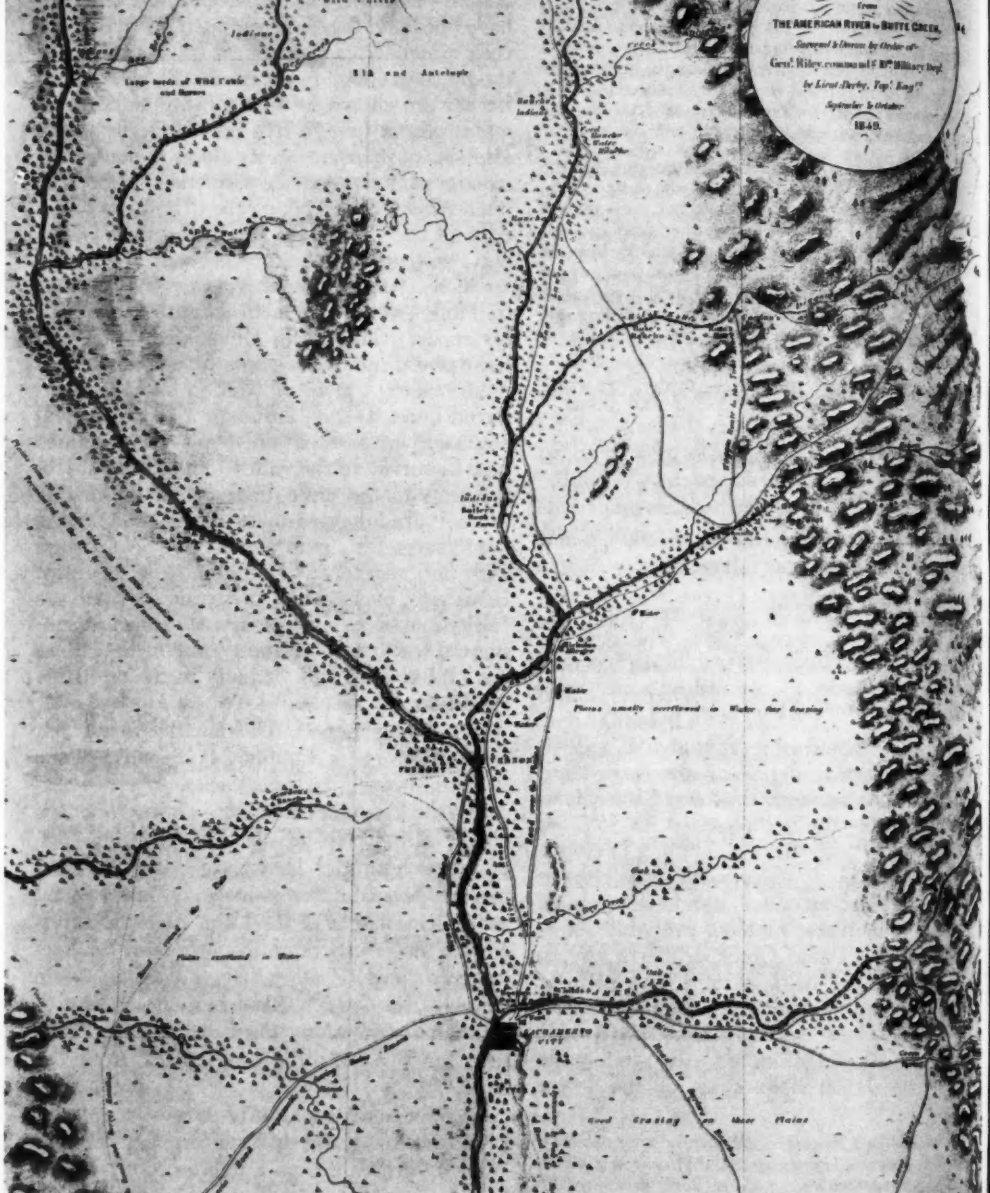

FIG. 3. A portion of George H. Derby's map of the Sacramento Valley, 1849. Source: Senate Executive Document No. 47, 31st Congress, 1st Session, 1850 (Report of the Secretary of War).

meager border."[78] Even more generally, but clearly indicating the variation of width in the riparian forests, the Railroad Reports refer to the riparian forests as "of greater or less width."[79] Moreover, the riparian forests varied not only in width but also in tree size and density, "the number and size of trees being apparently proportioned to the size of the stream and the quantity of moisture derived from it."[80]

Charles Nordhoff described the Pratt land grant in Butte County as follows:

> The next grant on the north is that of Judge O. C. Pratt. It contains twenty eight thousand acres of bottom-land. Butte Creek skirts it on one side for a distance of seventeen miles, and a branch of that creek runs through the centre. Nearly six thousand acres are covered with large oak-trees.[81]

Checking the above against a contemporary map[82] reveals that the Pratt grant was as Nordhoff described it, except that the area was actually 26,761 acres and the frontage on Butte Creek, forming its eastern boundary, was closer to 15 miles. If allowance is made for these smaller dimensions, and also for the fact that part of the "nearly six thousand acres" of "large oak-trees" was along Little Butte Creek (referred to by Nordhoff as the branch of Butte Creek that "runs through the centre" of the grant), then it would appear that the riparian forest was about one-half mile wide on the west bank of Butte Creek—a finding, incidentally, that agrees closely with the Derby map.

The preceding discussion shows that in their pristine condition the streams of the lower Sacramento River system were flanked by forests. The historical evidence suggests that these riparian forests had varied characteristics. They included trees of all sizes, from brush to very large valley oaks or sycamores, 75 to 100 feet high, growing closely spaced or scattered irregularly in groves. On the banks of the lower Sacramento, where the natural levees are widest, the riparian forests achieved their greatest width, four to five miles. On the lesser streams and in the delta, with smaller levees, the forests formed a narrower belt, generally about two miles wide but less in the delta. Dominant species in the riparian forest were valley oak (*Quercus lobata*), interior live oak (*Quercus wislizenii*), California sycamore (*Platanus racemosa*), Oregon ash (*Fraxinus oregana*), cottonwood (*Populus fremontii*), alder (*Alnus rhombifolia*), and several willows, including *Salix gooddingii, S. exigua, S. Hindoiana, S. lasiandra*, and *S. laevigata*.[83]

ECOLOGY OF THE RIPARIAN FORESTS

The prominence and significance of these riparian forests was enhanced by the fact that they were set in the nearly level and treeless plain of the Sacramento Valley. The virtually treeless character is attested by abundant historical evidence. There is no doubt that in recent centuries most of the valley supported grassy or herbaceous vegetation (including possibly nearly 1,000 square miles of tules and other marsh plants).[84] Precisely why the Sacra-

[78] *Reports of Explorations and Surveys, Geological Report*, p. 21.

[79] *Ibid., Botanical Report*, p. 14.

[80] *Ibid., Botanical Report*, p. 30.

[81] Charles Nordhoff, *Northern California, Oregon, and the Sandwich Islands* (New York: Harper and Brothers, 1877), p. 187.

[82] *Map of Butte County, California* (San Francisco: Wm. B. Cooke and Co., 1862).

[83] In his report on "The Riparian Botany of the Lower Sacramento" (*Erythea*, Vol. 1 1893, p. 242), Willis L. Jepson described the vegetation of the lower Sacramento River, mainly the delta, as follows:

> The major part of the growth is made up of various species of willow (*Salix nigra*, Marsh, *S. lasiandra*, Benth., and *S. longifolia*, Muhl.). Fine specimens of the Plane Tree (*Platanus racemosa*, Nutt.) are not uncommon. The Cottonwood (*Populus Fremontii*, Wats.) is frequent; while the Button Bush (*Cephalanthus occidentalis*, L.), the Oregon Ash (*Fraxinus Oregana*, Nutt.), the California Walnut (*Juglans Californica*, Wats.) and the Alder (*Alnus rhombifolia*, Nutt.), though not abundant, are to be met with throughout this entire region. The Wild Grape (*Vitis Californica*, Benth.) was noticed in several places. The undergrowth is largely a tangle of California Wild Rose (*Rosa Californica*, C. & S.) and Blackberry (*Rubus vitifolius*, C. & S.), with various herbaceous and suffrutescent plants. The Box-Elder (*Acer Californicum*, Freene) and Poison Ivy (*Rhus divarsiloba*, T. & G.) were noticed near Walnut Grove, as also fine individuals of the Live Oak (*Quercus wislizenii*, DC.) on the highest river banks. The River Dogwood (*Cornus pubescens*, Nutt.) is fairly frequent.

[The valley oak should also be included in this list.]

[84] The extent of marshes is difficult to estimate because of seasonal fluctuations and variations of definition. Hittell estimated the area of tule-land "covered five or six feet deep with water in times of flood" in the Sacramento Valley as 200 square miles, together with another 80 square miles on San Pablo Bay. (John S. Hittell, *The Resources of California* [San Francisco: A. Roman and Company, 1863], p. 12 and p. 157.) More likely correct are Hilgard's estimates of the areas of tule in Sacramento Valley counties which total 840 square miles and include only part of the delta. (E. W. Hilgard, *Report on the Physical and Agricultural Features of the State of California, with a discussion of the present and future of cotton production in the state; also, remarks on cotton culture in New Mexico, Utah, Arizona, and Mexico*, from the United States Census Re-

mento Valley was dominated by grasses is uncertain, as is so often the case with grasslands. It is possible, even probable, that grassland was the original great climax of the entire Central Valley. Clements theorizes that bunch grass formerly dominated the Central Valley until it was destroyed by fire, grazing, cultivation, and the invasion of ruderal grasses.[85] According to his interpretation, "the *Stipa* consociations seem formerly to have dominated the interior valley from Bakersfield to Mount Shasta and from the foothills of the Sierra Nevada and Cascade Mountains, through and over much of the Coast Range."[86] This view is based mainly on the discovery of numerous bunch grass relicts in the Central Valley. In addition to the grassland there were extensive areas of marsh vegetation, and, of course, the riparian forest in both the Sacramento and San Joaquin sections of the Central Valley.

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ports, Vol. 6 (Washington, D. C.: Superintendent of Census, 1883), pp. 87–92.) Hall's classification of the Sacramento Valley (below) indicates an even greater expanse of marsh although it does not show specifically the area of tule.

CLASSIFICATION OF SACRAMENTO VALLEY LANDS IN 1880

Designation	Area in Square Miles
High hill lands—Marysville Buttes	55.50
Low hill or rolling lands, adjacent to the foothills of the mountains	650.00
Dry plains, above reach of all overflow	2,321.45
Dry plains, subject to occasional temporary overflow from the tributary streams	450.00
Lands covered by debris and subject to flooding, river bottom or marginal lands naturally subject to temporary shallow annual overflow; low basin lands, not tule swamp, naturally subject to deep annual flooding; low basin lands, tule swamps, naturally subject to protracted deep annual flooding; island swamp lands and other tule swamps, naturally subject to flooding by high tides	1,254.00
River, slough, and channel surface of perennial streams	38.05
Total	4,769.00

Source: W. H. Hall, *Report of the Engineer to the Legislature of the State of California—Session of 1880, Part II, Drainage of the Valleys and the Improvement of the Navigation of Rivers* (Sacramento: Superintendent of State Printing, 1880), p. 7.

[85] Frederic E. Clements, *Plant Indicators, The Relation of Plant Communities to Process and Practice* (Washington, D. C.: Carnegie Institution, 1920), p. 150, and *Dynamics of Vegetation* (New York: H. W. Wilson, 1949), p. 184.

[86] *Plant Indicators*, p. 150.

The treeless character of the Sacramento Valley floor before agricultural occupation is explained by Jepson as a reflection of soil characteristics and climate.[87] Some portions of the Sacramento Valley—an area of diverse soil types—are too alkaline or sandy for native trees. In addition there are large tracts of heavy, adhesive, adobe soils that become dry and cracked in their upper layers during the dry season, and are glutinous during the wet season. Seedlings cannot naturally survive the summer desiccation in these adobe soils, although they flourish under man's care.

The extensive areas of clay soils, somewhat less heavy than the adobes, do not become so fissured with shrinkage cracks during the summer, but they possess this tree-deterring characteristic to a considerable extent. Further negative influences on tree growth on the valley floor resulted from the frequent widespread inundations of the flood basins and low plains that formerly occurred.[88] The restriction of tree growth was caused by insufficient aeration in the waterlogged soils rather than by too much water which, in itself, is not injurious. Periodic drought, the browsing of animals, and the desiccating effect of strong, dry topographically controlled north winds also militated against the development of trees. Even so, such circumstances have been judged insufficient to explain completely the dearth of trees over so much of the Sacramento Valley.

A probably important supplemental factor in minimizing tree growth was the widespread Indian practice of burning the luxuriant growth of dried-out grasses and herbaceous vegetation during summer. Numerous early visitors to the Sacramento Valley describe the great extent of these fires.[89] The burning of the valley herbs produced a quick, hot fire capable of killing seedlings but doing little damage to established trees. In this connection it may be noted that the valley oak's distinctive bark, often

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[87] Willis L. Jepson, *The Silva of California*, Memoirs of the University of California, Vol. 2 (Berkeley: The University Press, 1910), pp. 10–11.

[88] For further discussion of flooding in the Sacramento Valley see Kenneth Thompson, "Historic Flooding in the Sacramento Valley, California," *Pacific Historical Review*, Vol. 29 (1960), pp. 349–360.

[89] John Work, for example, noted in 1833 that near the junction of the Feather and Sacramento rivers "The country has recently been overrun by fire so that we can scarcely find feeding for our horses." Maloney, *op. cit.*, p. 70.

three or four inches thick, provides good fire-protection. Where present on the valley floor, the oaks usually stand in scattered groves—a distribution that might well be explained by an infrequent, localized combination of edaphic and biotic influences that permitted germinating seedlings to establish themselves. Presumably, grass fires were one of the major negative influences limiting the growth of seedlings.

Another authority, Cooper, suggests that while much of the Sacramento Valley may have been occupied by climatic grassland there is a possibility that parts of the valley, particularly at the northern end, were formerly controlled by chaparral.[90] This interpretation is supported by the fact that there are no marked climatic differences between the Sacramento Valley and the areas dominated today by chaparral. Furthermore, Cooper points to small areas of chaparral well out in the valley, in Colusa County between Hershey and Arbuckle, which are judged to be relicts. According to Cooper, the most important chaparral species, *Adenostoma fasciculatum*, cannot establish itself except when in mass control. He argues that where mature individuals of *Adenostoma* occur (as in parts of Colusa County), that species was formerly dominant and the area supported chaparral.

Cooper explains the elimination of the chaparral from the Sacramento Valley and elsewhere in California mainly through burning, possibly coupled with local clearing for cultivation and fuel. While admitting that fire favors the extension of chaparral at the expense of forest, he argues that *repeated* burning (such as occurred in the valley) favors grassland at the expense of chaparral. Recent work on range improvement supports this claim.[91]

Whatever the cause, there is no doubt that in its pristine condition the Sacramento Valley vegetation consisted largely of grasses and herbaceous plants, and that large areas were treeless. Jepson, writing in 1910, before the extensive reclamation and modification of the Sacramento Valley, but after the destruction of the riparian forests, described the Central Valley as follows:

> Extensive treeless areas are the most characteristic features of the Sacramento and San Joaquin valleys. The wooded areas are thin and limited in extent. The east side of the Sacramento and San Joaquin Valleys supports the greater part of the groves of scattered trees as contrasted with the west side which is in the main treeless.[92]

Jepson went on to note that the remaining woodland was largely restricted to the natural levees:

> Wherever trees are found on the plains proper, east side or west side, they are generally associated with the alluvial loams. This fact is related to the presence or absence of living streams and the mountain ranges in which the streams originate. On the east side of the "Great Valley" large rivers, emerging from the Sierra Nevada and flowing across the plains to the main arteries in the center of the valley, have built up alluvial deltas or have covered the plains with strata of the finest loam. The broad alluvial banks of these streams are often higher than the country lying behind them, particularly toward the foothills, and support open groves of Valley Oak and Interior Live Oak, which in some cases, although rarely, spread as a scattered growth over the inter-riparian plains. The west side of the San Joaquin and Sacramento valleys is similarly traversed by streams emerging from the Coast Ranges. While these are flood rivers in winter, they present dry beds in summer or towards the north only feeble streams. Wherever such streams have built up broad alluvial banks, as along Cache, Putah, Ulatis, and Alamo creeks, they support groves of scattered trees of the characteristic species named above.[93]

And similarly:

> On creek banks or in river bottoms, where on the other hand the soil is wet and the grass green all summer, we usually find dense stands composed of the characteristic Willows, Cottonwoods and other trees. The main rivers, especially, are marked by a dense arboreous fringe consisting of Black Willow, Red Willow, Yellow Willow, Box Elder, Common Cottonwood, Oregon Ash, Interior Live Oak, Valley Oak, and often with extensive areas of marsh lands filled with tule lying back of their alluvial banks.[94]

Jepson then relates the Sacramento Valley woodland to soil type (loams) and favorable ground-water conditions (natural levees or river banks)—a distribution confirmed for an earlier date from historical records and modern relicts. This distribution results from a number of factors. *Quercus lobata* is best developed where soil moisture is abundant, especially

[90] William S. Cooper, *The Broad-Sclerophyll Vegetation of California* (Washington, D. C.: Carnegie Institution, 1922), pp. 76–81.

[91] R. Merton Love and Burle J. Jones, *Improving California Brush Ranges*, California Agricultural Experiment Station Circular 371 (Berkeley: University of California, 1947), pp. 10–13.

[92] Jepson, *Silva*, p. 10.

[93] *Ibid.*, p. 10.

[94] *Ibid.*, pp. 11–12.

where the depth to the permanent water table is not too great. The loam soils of the riparian lands, pervious to rains and subsoil irrigation from the watercourses, provide not only favorable ground-water conditions but also soils of the highest fertility. Hence "it is the valley oak by necessity, as it is the valley oak *par excellence*." Valley oaks have a well-developed main root and numerous and large lateral roots. Both are capable of deep penetration, and the laterals may extend widely, but the greatest root development occurs fairly deep. It is thus well adapted to habitats where the soil moisture supply is abundant at a considerable depth, i.e., natural levee or riparian sites.[95]

Given the "water soaked condition of the soil, the richness of the alluvial land, and the heat of the unclouded summer sun, plant life in this region [i.e., riparian lands] is endowed with all the requisites for the most robust growth."[96] Accordingly, on riparian sites tree growth is relatively rapid and the trees attain very large sizes. Another favorable aspect of the natural levee or riparian site is relative freedom from fire. The numerous grass fires of aboriginal times probably had fairly little effect on the riparian forests. Since the burning was mainly conducted on the desiccated grasslands, toward the margins of the valley, the fires may not actually have reached the riparian forests, for the intervening swamps would have formed an effective firebreak. Furthermore, even where the fires did reach the levees the moist conditions assured a more verdant vegetation which reduced the possibilities of fire. Jepson, writing in 1893, contrasts the desiccated plains with the green river lands.

> The herbaceous plants on the plains are chiefly annual, and the rapidity with which they attain their full size, perfect their seeds, and pass away is the wonder of the botanical traveler. The wide plain is covered with showy Lupines, Clovers, Calandrinias, Platystemons, Baerias, Gilias, Nemophilas and Allocaryas. The shallow streams and pools are edged with handsome Euanani and curious Bolelias.[97] The tide of plant life reaches its maximum from April 5 to 20. In one, two, or three weeks more the brilliant colors have faded from the landscape and the vernal aspect is succeeded by the dullness and aridity of summer. For months there is nothing to be seen but the grass-whitened plain, only later relieved by tufts of Grindelia and broad areas of the exclusive Hemizonias.
>
> As the traveler passes late in the year from the sun-scorched plains to the riparian region, the change in the physiognomy of the country is decided and impressive. Even in September and October the river country is as fresh and green as the landscape in April on the plains of the Sacramento and in the lower foothills of the Sierra. The prevailing freshness of foliage is emphasized by the strength and richness of autumnal inflorescence . . . . The two regions which are here contrasted lie in closest proximity . . . .[98]

PRESENT CONDITION OF THE RIPARIAN FORESTS

Although the Sacramento Valley riparian forests were an early casualty of the white man, their destruction, far-reaching as it was, was not complete. Today, parts of both banks of the Sacramento and its tributaries are bordered by many shrunken remnants of the once extensive riparian woodland. The numerous traces that remain corroborate the historical evidence examined by the author. The same tree species mentioned in the historical records—mainly valley oaks, cottonwoods, willows, sycamores, and ash—still grow on the river banks, natural levees, and channel ridges. Typically, cottonwoods and willows predominate on the immediate stream banks, whereas valley oaks are spread irregularly over the natural levees farther away from the river.

Instead of a strip measurable in miles, the forested zones along the Sacramento Valley streams are now often only yards deep, and discontinuous at that. Generally, the remaining fragments (not necessarily virgin stands, of course) form a belt less than 100 yards wide and are largely confined to bank slopes of streams and sloughs, abandoned meanders, and on the river side of artificial levees.

Examination of the Sacramento River levees reveals hundreds of larger relict stands of riparian forest. Some cover only a few acres; others several hundred. Most prominent are fully mature specimens of valley oaks in the "weeping" stage of development described by Jepson as indicating an age between 125 and 300 years.[99] Such trees occur mostly on natural levee or channel ridge sites and are frequently around older settlements, presumably preserved for shade and ornament. Even small house lots

[95] W. A. Cannon, "Specialization in Vegetation and in Environment in California," *The Plant World*, Vol. 17, No. 8 (1914), pp. 234–235.
[96] Jepson, *Erythea*, p. 241.
[97] *Euanani* = *Mimulus*, *Bolelia* = *Downingia*.
[98] Jepson, *Erythea*, pp. 240–241.
[99] Jepson, *Silva*, p. 205.

may contain two or more oaks that predate the Anglo-American settlement period, presumably relicts of a more extensive stand. Some tracts of uncleared land near the Sacramento River (including two in Yolo County between Knights Landing and Elkhorn Ferry) are still so thickly studded with trees, including many valley oaks in the "weeping" stage, that they form the definite, if open, forest described by early visitors to the region.

Near Woodson Bridge, Tehama County, another expanse of apparently virgin riparian forest can be seen. It is still subject to almost annual overflow and is composed mainly of mature valley oaks, forming an open woodland that extends discontinuously for about a mile from the river's edge. Some splendid mature specimens of valley oak remaining from the Cache Creek riparian forest can be seen in the older residential sections of Woodland in Yolo County, which is named for the fine oak forest in which the settlement was established in 1855. Again, in and around Davis, also in Yolo County, there are many large relict oaks of the Putah Creek forests.

DISAPPEARANCE OF THE RIPARIAN FORESTS

In an area devoted so intensively to agriculture, it is not hard to explain the destruction of the riparian forests. Given the generally treeless nature of the valley floor the riparian forests were doomed to rapid effacement under Anglo-American occupance. Thus, Cronise, at the early date of 1868, could say of Tehama County that: "... the cottonwood and sycamore formerly growing along the Sacramento and other streams, being now nearly all cut away."[100] Referring to Colusa County, he wrote:

> Many of the water courses were originally skirted by narrow belts of trees, consisting chiefly of sycamore and cottonwood; but these having been mostly cut away the settled parts of the county are but scantily supplied with fuel and fencing timber.[101]

In his account of Yuba County, he noted that:

> The county is watered by the Feather River, separating it from Sutter on the west; by the Main Yuba and its Middle Fork; by Bear River dividing it from Placer and Sutter counties on the south; by Honecut creek, its northwestern boundary, and by Dry creek, running centrally through it from northeast to southwest. Originally the banks of these streams were timbered along their lower portions, after the manner common in this region—a few oaks being scattered over the valley lands and lower foot-hills. But most of this growth has now been removed ...[102]

Solano County was observed by Cronise to be

> ... one of the most sparsely timbered counties in the State; the prairies and hills being barren of trees of any kind whatever, while the growth along the water courses, originally limited in extent, is now nearly all cut away.[103]

In Sacramento County, as elsewhere, he noted the presence of

> ... oak, sycamore and cottonwood, being confined chiefly to the alluvial flats and the banks of the streams. The timber belt along the Sacramento was at one time so broad and dense as to render the navigation of that stream difficult by sail vessels, this craft often being several days making the passage even with a favorable wind from the mouth of the river to the Embarcadero [i. e., Sacramento city].[104]

Cronise's detailed observations attest to the previous existence and large-scale destruction by 1868 of the riparian forests. Several reasons account for the speed of this destruction. Of major importance was the cutting of the riparian trees for various domestic and industrial uses—e.g., as fuel and fence material. At Knights Landing, on the banks of the Sacramento River, in pioneer times huge quantities of cordwood were loaded on passing ships for use as fuel.[105] Since Knights Landing is backed by the treeless Yolo Basin, this wood must have come from the riparian forests of the Sacramento River and Cache Creek. It may be assumed that fueling the many wood-burning steam vessels on the Sacramento River system accounted for much of the early destruction.

In view of the general lack of trees in the Sacramento Valley, the riparian forests must have served as a source of fuel, construction, and other types of wood for a wide area. There was doubtless little incentive to conserve the riparian forests, since few of the tree species have much value as lumber. Typically the riparian forest species are fit only for low economic uses. For example, the numerous members of the genus *Salix* (willow) generally yield soft, light, and brittle wood of poor form for saw timber.

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[100] Titus Fey Cronise, *The Natural Wealth of California* (San Francisco: H. H. Bancroft, 1868), p. 289.
[101] *Ibid.*, p. 297.
[102] *Ibid.*, p. 300.
[103] *Ibid.*, p. 305.
[104] *Ibid.*, p. 309.
[105] Communication from local resident.

Rather similar is the cottonwood, which is soft, brittle, not durable, and especially liable to cracking.[106] The largest, and probably most numerous, riparian tree, the valley oak, is "very brittle, firm, often cross-grained and difficult to split or work. On account of its poor timber form the trees are rarely if ever cut for anything but fuel, for which, however, they are much used."[107] The genus *Platanus* (sycamore) is also of limited economic value.

Although California was, and still is, in the aggregate, richly endowed with timber resources, many areas of relatively dense settlement, particularly agricultural settlement, were poorly supplied with timber. The president of the principal agency then concerned with the promotion of agriculture, the California State Board of Agriculture, summarized the situation in 1868 as follows:

> The agricultural counties, as a general thing, have only narrow strips of timber along the water courses, consisting mostly of scrub oak, cottonwood, sycamore and willow, of but little general value, except for wood [i.e., fuel].[108]

The consequences of this situation were stated by the same person thus:

> The cost of lumber for building and fencing, in most of our agricultural districts, obtained, as it is, at a distance of hundreds of miles away, is even now so great that our farmers are among the poorest housed people of any agricultural community in the Union, where the country has been settled an equal length of time. Their crops and stock are but poorly sheltered, if at all, and their farms are worse than poorly fenced.[109]

Scarcity of timber in the agricultural sections of the state, mainly the Central Valley, was a matter of concern to the California State Agricultural Society, and as early as 1868 the society's president was urging that "premiums and bounties" should be offered for the planting of shade and forest trees.[110] By the winter of 1870 a premium of fifty dollars was awarded "for the largest quantity of useful forest trees planted during the year." There were three applicants for the award, one from Alameda County and two from Sacramento County.[111] The supporting statement of one of the unsuccessful applicants for the award casts light on the riparian forests and their destruction:

> The rapid disappearance of the forest trees all over our State, especially in localities bordering upon our rivers and sloughs, has for several years excited the attention of all who claim a home in California and feel an interest in the future welfare of our State.
>
> Since the writer became a resident of this county [i.e., Sacramento County], there was a fine growth of oak and sycamore timber bordering the Sacramento from the city to its mouth, which, it would be safe to say, would yield from one thousand-two hundred to two thousand cords of wood for every half mile, on either side. The oak trees were generally straight and handsome; many of them would make two rail cuts of twelve feet each in length, with several cords of wood left in the top. This fine growth of timber which once graced our river, tempered the atmosphere, and gave protection to the adjoining plains from the sweeping winds, has entirely disappeared—the woodchopper's axe has stripped the river farms of nearly all the hard wood timber, and the owners are now obliged to rely upon the growth of willows for firewood. One of the greatest disadvantages which the farmers of our plain lands labor under is the want of timber lands and forest trees. There is nothing to protect the growing grain, the young vineyards, or the newly planted orchard from the fierce northerly winds which visit us almost periodically, and generally come at the most critical time for the farmer, and in two days time blow his hope of a good harvest for the season into despair.[112]

In a similar vein was Nordhoff's suggestion, referring to the lack of trees in the Central Valley, that farmers should plant "live" fences of willow, sycamore, and cottonwood (typical riparian forest species) in December; and, as he optimistically put it, "these would strike root at once, and grow so rapidly that in the second year the farmer cuts his fire-wood from these living fences."[113] Another expression of the timber shortage in the Sacramento Valley was the eucalyptus-planting mania of the late nineteenth century.[114] In an area resorting to such

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[106] George B. Sudworth, *Forest Trees of the Pacific Slope* (Washington, D. C.: Department of Agriculture, 1908), pp. 212, 251.

[107] *Ibid.*, p. 278.

[108] Report to His Excellency, H. H. Haight, Governor of California, by C. F. Reed, President of the State Board of Agriculture, *Transactions of the California State Agricultural Society during the years 1868 and 1869* (Sacramento: State Printer, 1870), p. 29.

[109] *Ibid.*, p. 31.

[110] *Ibid.*, p. 33.

[111] "Winter Premiums for 1870, Artificial Forest Culture," *Transactions of the California State Agricultural Society during the Years 1870 and 1871* (Sacramento: State Printer, 1872), p. 132.

[112] "Statement of Mr. E. T. Aiken, of Sacramento County," *Ibid.*, pp. 133–134.

[113] Charles Nordhoff, *California for Health, Pleasure, and Residence* (New York: Harper and Brothers, 1882), p. 102.

[114] "Eucalyptus," *Sunset Magazine*, Vol. 117, No. 2 (August, 1956), pp. 44–47.

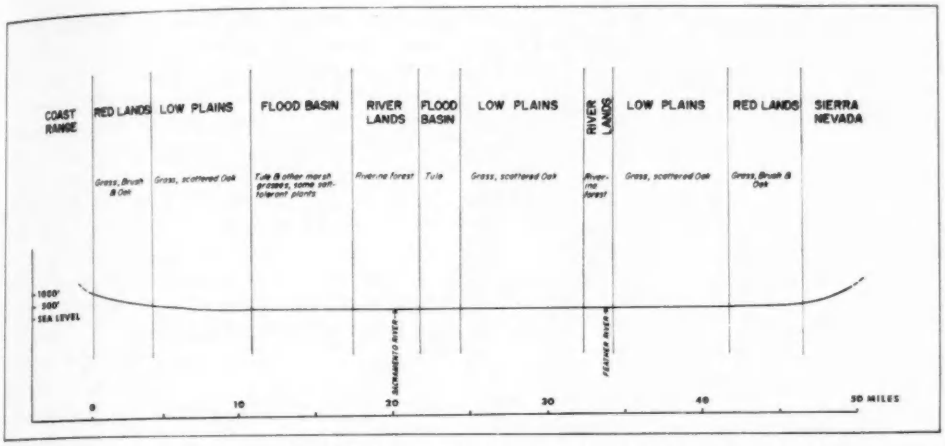

FIG. 4. Diagrammatic cross section of the Sacramento Valley, south of Sutter Buttes, showing the general relationship between physiography and vegetation.

measures to acquire a local timber supply it is hardly surprising that the riparian forests were quickly felled.

The clearing of the riparian forest for fuel and construction also served another end: it made available for agricultural use some of the most fertile and easily managed land in the valley. In its pristine, or nearly pristine, condition much of the valley was more or less unusable for agriculture because of waterlogging and inundations. Cultivation, and even stock-raising, on the valley floor prior to reclamation was notoriously hazardous. One danger was winter or spring flooding; thus Brace, after observing the Sacramento Valley in the late 1860's, recommended agricultural settlement in the Sierra foothills because there "the crops can never be drowned out by winter floods."[115] In addition there was the danger that light winter rains, or excessive summer heat, might cause an insufficient supply of water in the soil for crops. Crop failures for this reason were frequent. A government report issued in 1874, referring to the Central Valley generally, characterized crop failures from inadequate natural water supplies thus:

> ... the experience of the country ... is that one crop in three years or two crops in five years is all that can be raised.[116]

However, both these hazards were less severe on the river lands. Because of their higher elevations the levees were largely immune from inundation. Furthermore, they tended to be better drained than much of the other alluvial features because the levees and river lands were composed of coarser-textured soils. In general, these riparian soils were the most fertile and easily managed of the valley, and hence the first to attract agricultural settlement. This fact was recognized from the beginning; Hittell stated that "the richest soil is on the immediate bank."[117] Another early, and more explicit, statement along the same lines indicated that "the richest lands are the bottom lands, which fringe the rivers and larger streams for a distance of one to three miles."[118]

The flood protection offered by the natural levees was summarized by Bryan as follows:

> Although the height of these belts [i. e., the natural levees] above the adjacent country is not great, it is sufficient to make them habitable and arable and thus to separate them rather sharply from the swampy and frequently submerged wastes through which they extend for many miles.[119]

[115] Charles Loring Brace, *The New West or California in 1867–1868* (New York: G. P. Putnam and Son, 1869), p. 357.

[116] B. S. Alexander, G. H. Mendell, and G. Davidson, *Report of the Board of Commissioners on the Irrigation of the San Joaquin, Tulare, and Sacramento Valleys of the State of California*, House of Representatives, 43d Congress, 1st Session, Ex. Doc. No. 290 (Washington, D. C., 1874), p. 13.

[117] Hittell, *op. cit.*, p. 11.

[118] Anon., *A Memorial and Biographical History of Northern California* (Chicago: Lewis Publishing Company, 1891), p. 190.

[119] Bryan, *op. cit.*, p. 10.

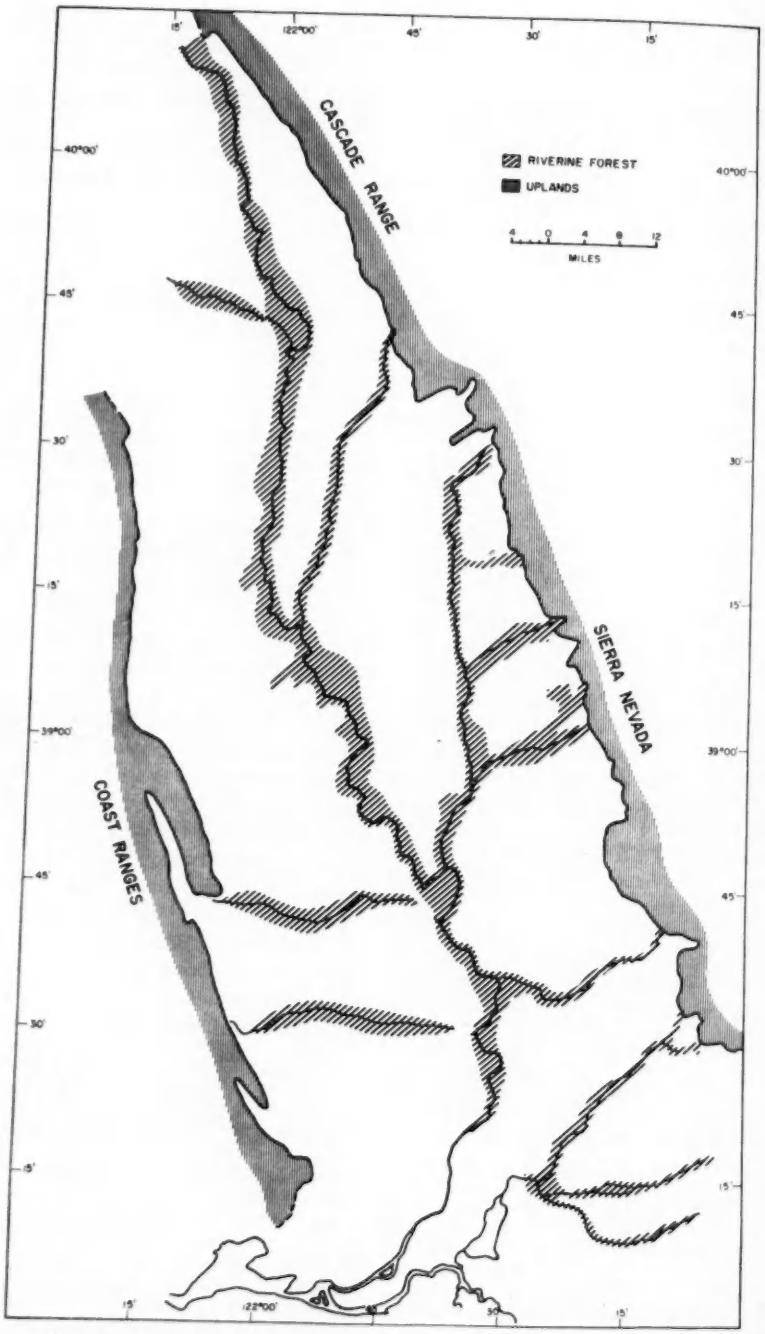

FIG. 5. Approximate extent of riparian forest in the Sacramento Valley.

The original limitations of many valley areas have been partially overcome in recent decades with improved drainage, irrigation, and other technical advances. However, initially these limitations were such as to discourage permanent settlement and agriculture on much of the valley floor with the exception of the natural levee lands. There both settlement and cultivation were concentrated; utilization of the remainder of the valley was uncertain and irregular, with much attention paid to livestock raising. The general superiority of the levee lands still holds. The most profitable form of land use in the valley, orchards, shows a very marked concentration on levee soils, a final confirmation of their inherent suitability for tree growth.

CONCLUSION

Although edaphic and biotic influences precluded trees from most of the Sacramento Valley in its pristine condition, the riparian lands (mainly natural levees) supported a flourishing tree growth—valley oak, sycamore, cottonwood, willow, and other species. A number of factors contributed to their presence—principally sub-irrigation, fertile alluvial loam soils, and relative freedom from surface waterlogging and fire. These riparian forests varied considerably in width, from a narrow strip to several miles. They also varied greatly in the spacing of the trees, from irregular open to fairly crowded stands, but were generally of sufficient extent and closeness to justify the term "forest" (Figs. 4 and 5).

Perhaps because the riparian forests were largely effaced during the first two or three decades of Anglo-American occupance their existence is largely overlooked by modern students of the Sacramento Valley. But this neglected element in the landscape is by no means of negligible importance. The riparian trees served to reinforce the river banks and provide greater stability to the stream channels. They also acted as windbreaks, reducing evaporation, transpiration, and wind damage. In addition, the riparian forests provided a haven for the wildlife of the valley, furnishing cover and food sources for land and arboreal animals. Even more important was the fact that acorns, mainly from *Quercus lobata*, was a staple foodstuff of the Indian population. Furthermore, the forests furnished an important source of wood in an area otherwise poorly supplied.

The mere existence of the riparian forests, however, inevitably spelled their doom. The conditions, characteristic of natural levee sites, that permitted their development—comparative freedom from flood and waterlogging, high soil fertility, and favorable soil moisture—eventually led to their destruction, for the existence of the forest was incompatible with the modes of land use initiated by the Anglo-Americans. Today, only a few traces of the formerly extensive riparian forests remain, and the Sacramento Valley exhibits a striking lack of trees.

THE USE OF SHADING PATTERNS IN GRADED SERIES[1]

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MAPS form a bridge of understanding between the cartographer and the map reader. Each map, like a painting, is a complex of visual stimuli which is effective only if all of its component symbols form a clear and well-directed unity. Unlike the artist, however, the cartographer must use his symbolization in very restricted ways since location and relative importance are ordained by his data. Each map symbol should have a visual importance equal to the significance of the item it represents, and while the map is a whole, each of its symbols is of separate concern to the cartographer.

The visual importance of a symbol on a map is determined by the degree of contrast between that symbol and all adjacent symbols. Visual contrast of word, point, and line symbols is achieved by varying hue (color), size, shape, and value as measures of lightness or darkness. Area symbols cannot be contrasted in size or shape (areal outline) since these are determined by the nature of the distribution being mapped. On one-color maps contrasts between areas are mainly achieved by varying value, although contrast also results from variations in pattern texture and style. The greatest contrast occurs when black and white areas adjoin on a map; lesser degrees of contrast result when black and gray, white and gray, or two tones of gray are contiguous. Shadings of different styles or textures, having the same value, create relatively little contrast.

The selection of area symbols that combine to give clarity and unity to a map is especially difficult. The cartographer must consider how the area shadings are to be used, what reduction and reproduction problems are involved, and what style and texture of pattern is best suited to a particular problem. He must also concern himself with the visual contrast between patterns, and, if patterns are to be used in sequences, what values give the best visual representation of a scale ranging from light to dark. These questions become more acute because a large proportion of maps made by individual cartographers are printed in black and white, thereby losing the greater contrasts that appear on color maps. The limited skill, facilities, time, and funds of many cartographers also add to the complexity of pattern use by limiting selection to readily available self-adhesive shadings. Since there are no clearly defined principles to serve as a guide, most map makers use the trial and error method of pattern selection. An examination of our literature shows that this has resulted in a high proportion of unsatisfactory maps.

This paper attempts to bring some organization to the problems encountered in using self-adhesive shading patterns on one-color maps by: (1) summarizing shading pattern use, (2) determining the reduction and reproduction limits of shadings, (3) reporting and testing map-user preferences for pattern style and texture when patterns are used in a graded series, (4) analyzing scales of the gray spectrum, and (5) attempting to determine the most practical gray scale for map use.

Much of the discussion centers around topic five since it was hoped that testing would make it possible to evolve a cartographic tool of some value. Unfortunately, the psychophysical and cartographic complexities of the problem have shown the need for more research and the results are less complete than originally visualized. It has been possible, however, to develop guide lines for the use of a graded series of shadings on isarithmic maps.

REDUCTION AND REPRODUCTION PROBLEMS IN THE USE OF SELF-ADHESIVE SHADINGS

Theoretically, reproduction of shading patterns should not affect the value of the tones, even at reduced scale. Many cartographers, however, have experienced failures where patterns have either "dropped-out" or "closed-up" in the reproduction process. This is a vexing problem since a pattern may be used satisfactorily at one reduction or with one printing technique and give poor results with another. The problem becomes especially acute when dot style patterns of fine texture are used.

[1] This study was supported by the General Research Fund of the University of Kansas. The authors are indebted to the following research assistants: Bradford L. Thomas, Thomas E. Ryther, Ronald E. Obenchain, Carol F. Gibbs, Franz R. Semmelmann, Harry L. Lane and Kenneth P. Ring.

One solution to the reproduction problem is found in pre-printing a variety of patterns which might be used in a graded series and then selecting only those that reproduce satisfactorily. In the preparation of this study, several tests of this type were made using different types of printing on different qualities of paper and at different scales of reduction. These tests were intentionally made using printing and paper of low quality since it was assumed that labor and materials of this type could be obtained almost everywhere. An analysis of these printings permits the following generalizations about the reproduction qualities of self-adhesive shading media on maps or graphs when the final print is two-thirds of the original scale: (1) black dots should not be used on the original drawing if their diameter is less than .012" (dots similar to those found in Zip-atone 3, Craftone 30, or Artype 4000); (2) white dots in a black background should be at least .015" in diameter (dots similar to those found in Zip-atone Z-W or Craftone 83W); (3) black lines should have a width of at least .008" (Pelican point A.2); and (4) white lines should have a width of at least .012" (Pelican point A.3 or Leroy #000). If printing of high quality can be obtained, these values can all be reduced by approximately 25 percent.

THE USE OF AREA SHADINGS ON ONE-COLOR MAPS

Area shadings may be used for emphasis, to differentiate kind, or to show varying intensities of the same distribution. Single patterns are often used for emphasis; e.g., coastlines are emphasized by applying a tone either to the land or water area, and city locations are emphasized when a tone is applied within the city limits to make the cities stand out from the surrounding countryside. Combinations of shadings of different styles (shape of pattern) are used to differentiate "kind" on maps depicting such phenomena as vegetation, geology, and land use. Patterns in an ordered series of tones are normally used for maps of quantitative distributions, such as amount of rainfall or elevation above sea level. In this case, the data on the map are subdivided areally through the use of isarithmic lines. If data are to be subdivided areally by dasymetric lines,[2] an ordered series of tones is still used, but the order is demonstrated only in the legend box, since the patterns appear on the body of the map in a somewhat random fashion as determined by the data.

Since area shadings can be used in different ways, and in different styles, textures, and numbers, the selection of shadings is not a single problem but a complex of related problems. The selection of individual patterns is not an isolated decision, but a decision based upon the relationship of a particular pattern to all other patterns. The cartographer must, above all else, retain clarity and avoid visual confusion in the use of patterns.[3] The selection of an individual pattern is further complicated by the fact that the cartographer ordinarily uses only six to ten of the more than 2,000 self-adhesive shadings that are readily available.[4]

The shadings used in the tests of gray scales, discussed later, were selected from some 400 different dot patterns that were tested by pre-printing. A selected list of these patterns and a small sample block of each is shown in Figure 6. Many more patterns successfully passed this pre-printed test but were rejected because they were almost identical with those in Figure 6, or because they did not fall into the proper textural range.

Printers designate the texture of shadings by the number of rows of dots or lines per inch. All of the patterns used in Figure 6 fall within the range of 25 to 50 lines per inch. At printed scale (⅓ reduction) these screens are 37.5 to 75 lines per inch. While these are not fine screen as compared to those used in high quality printing, they are fine enough to produce the appearance of a general overall tone and, therefore, partially achieve the fine texture requirements discussed in the following section.

The patterns shown in Figure 6 indicate that there are considerable differences in the textures of the shadings. This is unfortunate, for

[2] Francis J. Marschner, "Rural Population Density in the Southern Appalachians," *Miscellaneous Publication*, United States Department of Agriculture, No. 367 (March 1940), p. 18. Also see Arthur H. Robinson, *Elements of Cartography*, 2nd Ed. (New York: John Wiley, 1960), p. 174.

[3] Robinson, *op. cit.*, pp. 175–77, 232–34.

[4] For a selected list of trade-named shadings and manufacturers see *Artype* (Artype Inc., Barrington, Illinois); *Contak Shading Film* (Transography Co., 30 West 15th Street, New York 11, New York); *Craftone* (The Craftint Mfg. Co., 1615 Collamer Ave., Cleveland 10, Ohio); *Zip-atone* (Para-tone Inc., 512 West Burlington Ave., La Grange, Illinois).

uniformity of texture in a graded series of shading is preferred, but even in the 2,000 readily available self-adhesive shadings it is impossible to select such a wide range of values and maintain uniform texture. The screens selected for Figure 6 are the finest textures available for the desired value (lightness or darkness) that will print clearly under average conditions.[5]

MAP-USER PREFERENCES IN PATTERN STYLE AND TEXTURE FOR A GRADED SERIES

Self-adhesive shadings are available in three basic styles and in a variety of different textures. The three styles are: dot patterns, with uniformly sized dots arranged in rows; line patterns, with uniform parallel lines evenly spaced; and irregular patterns composed of irregularly shaped ink spots arranged either randomly or systematically. A large proportion of the available irregular patterns fall either into geologic or vegetative symbol categories. All three styles of patterns are available in coarse, medium or fine textures, and in shades of varying value (lightness or darkness).

It is possible to construct a graded series of tones within any given style of pattern, although dot or line patterns are usually used. Not infrequently, patterns of different styles are combined in a graded series, particularly if the series consists of more than seven categories. It is also possible to construct graded series with different textural characteristics and different textures are often found within a single graded series.

Raisz and Robinson both recommend the use of fine textures and Robinson explicitly points out that fine-textured dot patterns are preferable since there is less visual interference with other symbols.[6] This is a rather commonly accepted hypothesis evidently based almost wholly on experience in using shading media. In order to test map-user preferences in pattern texture and style, a series of 24 plates were constructed. Each plate consisted of four identical maps with shadings in a graded series. One map on each plate was constructed with line patterns, one with irregular patterns, and two maps with dot patterns. The finer texture of the dot patterns contrasts with the coarser textures of the line and irregular patterns (see Fig. 1). Further variations were imposed by placing alternating line patterns on some plates at right angles to each other, while the line patterns on other plates were all placed so that the lines were parallel. Different reductions were also used.

These plates were presented to 129 persons and each was asked, "Which map do you find most pleasing or like the best?" Since there were a variety of different pattern styles and textures it was felt that answers to this question would give some clue to what type of pattern should be used on a map with shadings in a graded series. It was also felt that the test would indicate whether fine-grained patterns cause less visual interference with each other and with the isarithmic lines that separate them.

A chi square test of the significant differences in the frequencies of choice among the four maps on each plate was applied to the answers to this question. The results of this test are shown in Table 1. The same plates were again presented to the testees and they were asked, "Which map do you think has the most displeasing set of patterns?" The same statistical procedures were applied to the second question. The results of these manipulations are shown in Table 2.

The results of these tests allow the following conclusions:

1. Map users prefer dot styles when patterns

[5] A word of caution concerning the application of shading films is in order. All shading film must be firmly burnished down to the original drawing. No air bubbles should remain after burnishing since they cause refraction of the light rays during photography. This refraction may result in dots being dropped out, changes in the relative diameters of the dots in the bubble area, or, in extreme cases, the bubble may photograph as solid color. Bubbles can easily be removed if they are pricked with a needle and the area burnished down again.

Some of the shading films available are produced with the ink of the pattern on top of the film while others are inked on the adhesive side of the film. If the ink is on top of the film, care must be taken to protect the pattern during the burnishing process, so that part of the tone is not removed. This can be done by placing a piece of paper over the pattern during burnishing. Particular care is necessary when patterns printed in white ink are used since the damage is not readily apparent in the original drawing, but changes in tone may be all too apparent in the photographic or printed copy.

[6] Robinson, *op. cit.*, p. 232, and Erwin Raisz, *General Cartography* (New York: McGraw-Hill, 1948), p. 248.

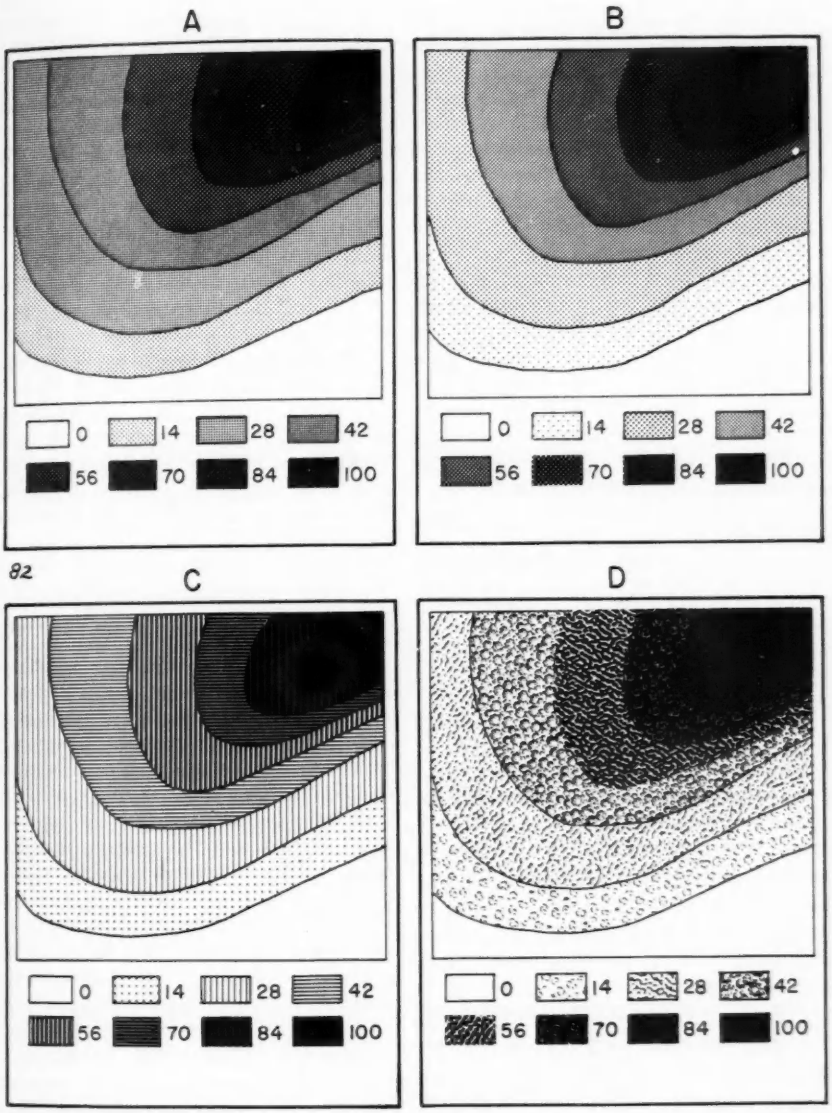


FIG. 1. A sample plate from the test used to determine map-user preferences in pattern style and texture. The plate was reproduced at 67 percent of original scale. Plates were also reproduced at 100 percent and 35 percent of original scale.

are used in a graded series. This holds true regardless of the number of patterns used in the series. Note the predominance of first choice in categories A and B in Table 1. These categories (A and B) are composed of fine-textured dot series. It is also interesting to note that for full-scale reproduction or 67 percent reduction from full scale, the predominant choice is for category B, while for reproduction at one-third of original scale (an extreme reduction), the predominant choice is category A. This is not surprising since the light value dot

TABLE 1.—CHI SQUARE TESTS OF SIGNIFICANCE OF DIFFERENCES BETWEEN TEXTURE TYPES AND THE MOST PLEASING SERIES OF PATTERNS

Number of patterns	Reproduction scale	Chi square	Order of choice[1]				Significant[2]
			A	B	C	D	
4		6.85	4	1	2	2	no
5		38.22	3	1	2	4	yes
6	100%	20.69	1	3	2	4	yes
7		19.03	2	1	3	4	yes
8		4.56	1	2	3	4	no
4		23.29	4	1	3	2	yes
5	67%	34.80	3	1	2	4	yes
6		9.81	3	2	1	4	yes
7		12.38	4	1	3	2	yes
8		15.96	2	1	3	4	yes
4		12.78	1	3	2	4	yes
5	33%	19.08	1	3	4	2	yes
6		13.82	1	2	3	4	yes
7		37.33	3	1	4	2	yes
8		24.55	1	3	2	4	yes

[1] A—Dark dot series, fine texture.
B—Light dot series, fine texture.
C—Lines, medium texture.
D—Irregular styles, coarse texture.
[2] The least significant value of chi square with 3 degrees of freedom where $P = .05$ is 7.82.

TABLE 2.—CHI SQUARE TESTS OF SIGNIFICANCE OF DIFFERENCES BETWEEN TEXTURE TYPES AND THE LEAST PLEASING SERIES OF PATTERNS

Number of patterns	Reproduction scale	Chi square	Order of choice[1]				Significant[2]
			A	B	C	D	
4		53.85	4	3	1	2	yes
5		211.06	3	4	2	1	yes
6	100%	76.62	3	4	1	2	yes
7		219.30	3	4	2	1	yes
8		143.59	3	4	2	1	yes
4		64.85	3	4	2	1	yes
5		156.84	3	4	2	1	yes
6	67%	53.54	3	4	2	1	yes
7		208.28	4	4	2	1	yes
8		178.56	3	4	2	1	yes
4		70.68	2	3	4	1	yes
5		156.73	2	4	3	1	yes
6	33%	90.78	4	3	2	1	yes
7		199.00	3	4	2	1	yes
8		171.41	3	4	2	1	yes

[1] A—Dark dot series, fine texture.
B—Light dot series, fine texture.
C—Lines, medium texture.
D—Irregular styles, coarse texture.
[2] The least highly significant value of chi square with 3 degrees of freedom where $P = .001$ is 16.27.

patterns that make up category B become visually weak at extreme reduction. The above conclusion is further strengthened by an analysis of Table 2 which presents test results concerning choices of a least pleasing series of patterns.

2. Comparisons of the chi square values in Tables 1 and 2 show that the respondents found it much easier to select the most displeasing map than to select the most pleasing map on each plate. This is reasonable since there were two maps per plate with fine texture, while there was only one with medium texture and one with coarse texture.

3. Analysis of results of these tests indicates that if line patterns are used in a graded series it makes little difference whether adjacent patterns are placed parallel or at right angles to each other.

4. A chi square test of the relationship between reduction and the number of respondents who could make no choice among the four categories reveals a highly significant association ("most pleasing" 15.25, "least pleasing" 28.84, with $N = 129$). It may be that pattern styles, other than dots, are more acceptable when presented at reduced scale since coarseness of texture decreases with reduction.

VALUE SCALES OF THE GRAY SPECTRUM

A value scale of the gray spectrum is an arrangement of tones ranging from white through gray to black. The gray tones composing such a scale are completely neutral, having no chromatic content, and may be made up of flat tones, such as those made with paint, or they may be composed of shadings which, if fine textured, give the appearance of flat tones. Value scales, if painted, could be continuous in gradation, but such scales, when made from pre-printed self-adhesive shadings, become discontinuous steps of varying values (lightness or darkness). The number of steps in a scale is limited either by the ability of the viewer to discriminate between tones or by the practical application of the scale. In mapping, value scales usually range from four to nine steps. Experienced cartographers sometimes use more than nine steps, but when this is done map readers frequently complain of great difficulty in discrimination.

The problem of constructing a stepped value scale from shadings is centered on the selection of a series of tones which give visually equal appearing steps from white to black. Several different theories for selecting equal appearing steps in the gray spectrum have been proposed, but having been developed with different

graphic media, at different times and in different academic disciplines, there is considerable variation in tonal arrangement. For example, one theory might represent the 50 percent step with a tone composed of dots that cover 50 percent of the area, while another might represent the same visual value with a tone composed of dots that cover only 25 percent of the area. The first theory assumes that if 50 percent of the surface of the paper is covered with ink the viewer will automatically evaluate the resultant tone as being halfway from white to black. The second theory assumes that a tone covering 25 percent of the surface of the paper will also appear to be halfway between white and black.

The existing gray scale theories pose serious problems for cartographers, for none of them was developed using maps or commercially available self-adhesive shadings. In mapping situations the area covered by different tones varies in both size and shape. Consequently, it may be assumed that maps present different visual relationships than those found in the testing procedures used in developing these scales. Furthermore, the visual properties of self-adhesive shadings may differ substantially from flat tones of paint or shadows. It follows, therefore, that the various theories must be tested in mapping situations.

For this purpose, the seven value scales most frequently discussed in the literature dealing with a graded series of tones were selected for analysis with the hope that this number could be narrowed down to four or five for testing. Since these scales were developed at different times, in different academic disciplines, and using different materials and techniques, the first step in analysis involved transfer of all to a common terminological and graphic base. This transfer entailed risk of misinterpretation of terminology since the definition of a word or phrase may vary from time to time and from discipline to discipline.[7] The percent of blackness perceived was considered to be analogous to, but reversed in percentage from, the terms "value" and "sensation." For example, high "value" in psychological terms is 100 percent white, while in terms of blackness perceived, white is equal to 0 percent. Percent of area inked was considered to be analogous to "stimulus" and "reflectance." For example, in psychological terms, white has 100 percent "reflectance"; on the basis of the percentage of area inked, white is equal to 0 percent. While the assumptions made in transferring these seven scales to a common terminological basis may be questioned, as Robinson questions Williams' equation of reflectance with stimulus,[8] the purpose of our test was to find the existing value scale that most closely fits the needs of cartographers using commercial shading media. This is an empirical use of value scales and is not concerned essentially with the psychophysical problems of vision. If the most adequate scale for this use can be found, regardless of the original intent of the developer of the scale, our purpose will have been well served.

Seven value scales are presented in Figure 2, A–G. The heavy black lines on the graphs represent each author's curve of the gray spectrum when transferred to a common terminological and graphic base. The vertical axes of the graphs are identical and indicate three equal appearing steps of gray between white and black. From these points on the vertical axis, parallel lines extend to each heavy curve and then drop down to the horizontal axis. Along the horizontal axis the percent of inked area necessary to produce the "equal appearing steps" is given.

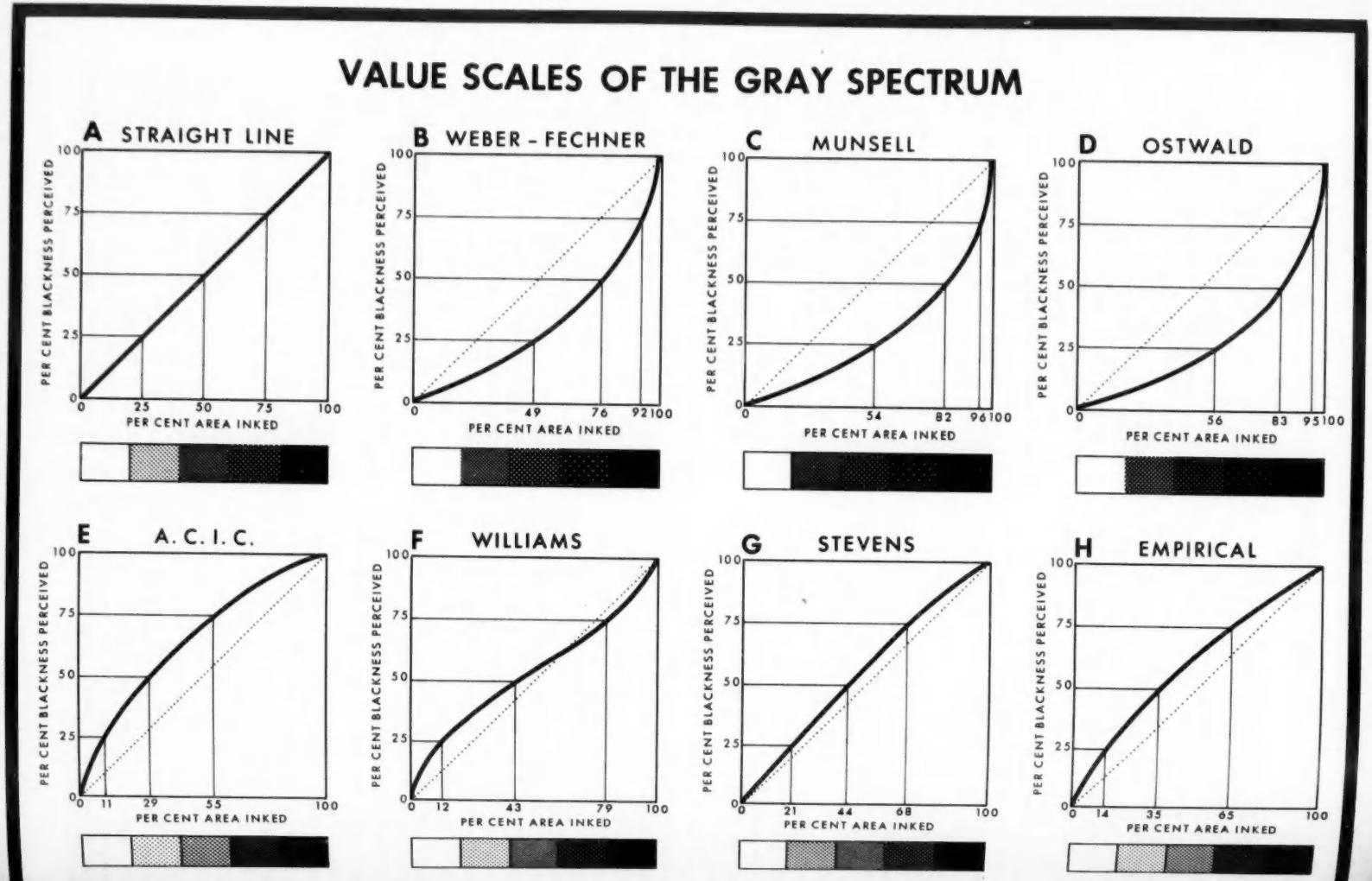
An analysis of each curve follows:

A. *Straight Line.* While still used in some gray scales, this straight-line relationship between the darkness perceived and area inked is generally disregarded by psychologists. A straight-line function implies that perception of the darkness of tones increases at an equal rate with increases in the area inked: therefore, a visual impression of 50 percent black will result if a pattern has an inked area of 50 percent.

B. *Weber-Fechner.* The Weber-Fechner law states that sensation is proportional to the logarithm of the stimulus. This law was developed using illuminated targets to determine

[7] At the present time it is not known whether printed screens will cause the same visual reaction as the materials used in developing the above value scales. We have assumed that reflectance from a gray surface, whether a flat tone, a lighted target, or a section of shading media will all cause the same reaction if the value is the same.

[8] Robert L. Williams, "Map Symbols: 'The Curve of the Grey Spectrum'—An Answer," *Annals*, Association of American Geographers, Vol. 50 (1960), pp. 487–91.


VALUE SCALES OF THE GRAY SPECTRUM
A STRAIGHT LINE
B WEBER - FECHNER
C MUNSELL
D OSTWALD
E A. C. I. C.
F WILLIAMS
G STEVENS
H EMPIRICAL
PER CENT BLACKNESS PERCEIVED
PER CENT AREA INKED
0 25 50 75 100
0 49 76 92 100
0 54 82 96 100
0 56 83 95 100
0 11 29 55 100
0 12 43 79 100
0 21 44 68 100
0 14 35 65 100

brightness values. The data for the curve shown here were taken from a contribution by Lloyd A. Jones.[9] As will be seen in Figure 2B, a higher percentage of ink is required to represent a given visual tone than is necessary for the same visual tone in the straight-line relationship, i.e., a tone appearing as 50 percent black should be represented by a pattern with an inked area of 76 percent. The shape of the Weber-Fechner curve means that it is easier to distinguish slight differences in darker tones than in lighter tones.

C. *Munsell.* The Munsell scale was derived by establishing value differences by two methods which gave almost identical results. One scale was determined by the J.N.D. (Just-Noticeable-Difference) method using strips of gray paper. Both scales were developed against backgrounds with a reflectance of about 18 percent.[10] The similarity of the Munsell and Weber-Fechner scales is noteworthy.

D. *Ostwald.* Ostwald "intended that this scale show visually equidistant steps," and to accomplish this he drew upon the brightness discrimination data of Weber and Fechner.[11]

As can be seen on the horizontal axes of graphs 2B, C, and D, the percent of area inked is greater than the visual impression that it creates. While these three scales are very similar, a greater percentage of inked area is required to represent a visual 50 percent black on the Munsell scale than on the Weber-Fechner scale, and a still greater percentage is required on the Ostwald scale.

E. *A.C.I.C.* This curve was developed in an attempt to standardize the continuity of gradient tints on aeronautical charts and as such is the first presented here that is directly related to maps. While the method of derivation is not explicitly stated, the following statement relates it to those considered previously:

> A basic principle suggested by Mr. Seibert of the technical staff resolved our problem with the application of a principle of Dr. Wilhelm Ostwald. Dr. Ostwald's principle simply states that the human eye does not perceive photomechanically but photochemically. Its sensitiveness from dark to light varies logarithmetically, not arithmetically. Our technical development staff thereupon converted the Ostwald analytical grey scale to the dot screen percentage, so that the resultant printed percentages would have analytical values comparable to the Ostwald grey scale. Conversion of the principle to give comparative reflection values for human eye interpretation resulted in a set standard screen percentages of 5, 10, 17, 28, 35, 42, 58, 76, and 100 percent of its coverage.[12]

It will be noted that while this curve has the same general shape as the previous ones, it is on the opposite side of the straight-line relationship. In terms of percentage of darkness perceived, this curve means that it is easier to distinguish the difference between lighter shades than darker shades of gray. This, of course, is opposite to the theses of Weber-Fechner, Munsell, and Ostwald. To represent a perceived darkness of 25 percent, the Weber-Fechner curve requires an inked area of 49 percent, while on the A.C.I.C. curve an inked area of 11 percent is required.

Other cartographers, through experience in the use of self-adhesive shadings, have come to the same conclusion as the A.C.I.C. As Robinson states, "It is easier to distinguish light gradations than dark gradations if the progression is arithmetic." Because the arithmetic steps in value at the dark end of the scale are more widely spaced (indicating lessened ability to perceive differences) than those of the Weber-Fechner, Munsell, or Ostwald scales, this can be interpreted to mean that the A.C.I.C. scale is preferable from the point of view of the cartographer working with map situations, and, in fact, it is almost identical to the tentative scale presented as Figure 97 in Robinson's text.[13] It is interesting to note that Robinson omitted this figure from his second edition. In a discussion of this subject, he stated that he felt that the straight-line relationship was probably closer to being correct than this one.

[9] J. K. Wright, *et al.*, "Notes on Statistical Mapping, with Special Reference to the Mapping of Population Phenomena" (New York: American Geographical Society; Washington: Population Association of America, 1938).

[10] A. E. O. Munsell, L. L. Sloan, and I. H. Godlove, "Neutral Value Scales. I. Munsell Neutral Value Scale," *Journal of the Optical Society of America*, Vol. 23, No. 11 (1933), pp. 394–411.

[11] Egbert Jacobson, Walter C. Granville, and Carl E. Foss, *Color Harmony Manual, Explanatory Text to Third Edition* (Chicago: Container Corporation of America, 1948), p. 39.

[12] Aeronautical Chart and Information Center, 4. "Standardization and Production of Screen Tints," in Part VII of *Information Relative to Cartography and Geodesy*, Series II: German Contributions in Foreign Languages, Second International Cartographic Conference, June 15–21, 1959 (Frankfurt: Verlag des Instituts für Angeandte Geodasie, 1959), pp. 17–18.

[13] Arthur H. Robinson, *Elements of Cartography* (New York: John Wiley, 1953), p. 129.

F. *Williams.* The Williams' scale[14] was developed through a series of tests conducted with tones printed on stamps. A full range of tones, randomly arranged, was given to each subject, who selected several that seemed to give even appearing steps between two given tones.

It will be noted that the Williams' curve agrees in the lighter tones with that of the A.C.I.C. and in the darker tones crosses the straight-line relationship and approaches that of the Weber-Fechner, Munsell, and Ostwald curves. Essentially this scale means that it is easier to distinguish differences in tones in both the lighter and darker ranges than it is in the middle grays.

G. *Stevens.* The eminent psychologist, S. S. Stevens, refutes the concept of the logarithmic relationship between sensation and stimulus developed by Fechner in this statement:[15]

> Fechner's logarithmic law is not found in experiment for the simple reason that resolving power (the J.N.D.) is not constant in psychological units, but is roughly proportional to psychological magnitude. For this reason, all procedures of Fechnarian extraction, like the method of paired comparisons and its related techniques, which seem to build scales out of "unitized" measures of dispersion, are not proper methods for scaling magnitudes that behave like Class I or prothetic continua (continua having to do with "how much" as opposed to continua having to do with "what kind" and "where"). Whenever psychological scales are called for, direct ratio scaling methods should probably be used.

According to Stevens, "psychological magnitude is a power function of the stimulus magnitude," which is stated as $\psi = KS^n$, when ψ is the sensation, K is a constant, and S^n the stimulus raised to a power. The approximate exponent which he assigns to lightness of grays is 1.2 and that for brightness .3–.5. The graph 2G is plotted using the exponent 1.2. If a similar graph were plotted using .3–.5 the curve would fall in a position similar to the Weber-Fechner curve.

In discussing brightness and the lightness of grays, Stevens further states: "When grays of different reflectances are viewed under ordinary illumination, light adaptation and contrast both operate to increase the steepness of the brightness function to a different order of magnitude from that observed with luminous targets seen in the dark." Stevens' work thus appears to justify the A.C.I.C. transformation of the Ostwald scale.

H. *Empirical.* Experiments with the various scales using self-adhesive shadings seemed to indicate that Stevens' scale is correct in the darker part of the spectrum while that of the A.C.I.C. and Williams appear to be more correct in the lighter parts of the spectrum. The empirical curve was, therefore, designed to incorporate these seemingly superior aspects of all three scales into one. The empirical scale is expressed as a percentage. This scale, like the A.C.I.C. and Stevens' scales, requires less percentage of inked area to represent visually equal steps than do the scales shown in Figure 2A, B, C, and D.

The series of graded tones below each graph in Figure 2 makes it possible to compare the application of the various theories to the selection of self-adhesive shadings. Each tonal scale is composed of white, black, and three intermediate tones. The inked area of these intermediate tones is given on the horizontal axis of each graph and the visual values which each scale represents are given on the vertical axis. A comparison of these graded tonal scales shows that in practical application widely divergent values result, although each scale supposedly represents "equal appearing" steps from white to black. Obviously, not all of the above tonal scales give equal appearing steps. For example, the first step in the Weber-Fechner, Munsell, and Ostwald scales have much greater contrast than any of the following steps.

Practical experience of cartographers in using self-adhesive shadings points toward a much lighter contrast for this first step. Nowhere in the cartographic literature is such a great contrast for the first step of a gray scale recommended, nor can such a scale be found in use on any recently published map. For these reasons the Weber-Fechner, Munsell, and Ostwald value scales were omitted in testing for a practical value scale for map use. This decision is bolstered by the fact that the A.C.I.C. scale was designed and is used successfully on

[14] Robert L. Williams, *Statistical Symbols for Maps: Their Design and Relative Values* (New Haven: Map Laboratory, Yale University, March 1956), pp. 84–115. Also see Robert L. Williams, "Map Symbols; Equal Appearing Intervals for Printed Screens," *Annals*, Association of American Geographers, Vol. 48 (1958), pp. 132–39.

[15] S. S. Stevens, "On the Psychophysical Law," *Psychological Review*, Vol. 64 (1957), pp. 153–81, and S. S. Stevens, "The Psycholophysics of Sensory Function," *American Scientist*, Vol. 48 (1960), pp. 226–53.

maps and the Williams' scale was developed for map use. Further, Stevens' scale for the gray spectrum approaches the A.C.I.C. and Williams' scales, while his scale for brightness is similar to those of Weber-Fechner, Munsell, and Ostwald. Thus, testing was carried out using the Straight-Line, A.C.I.C., Williams, Stevens, and Empirical value scales.

TESTS DETERMINING A PRACTICAL VALUE SCALE FOR USE ON MAPS

A practical value scale, from the cartographic point of view, must function in rather broad physical and psychological environments. The cartographer ordinarily has little or no control over the intensity or color of light under which a map is viewed, nor can he control the degree of light adaptation of the viewer. Similarly, he has no control over the physical or psychological well-being of the map reader. The reflectance of the paper and ink used in printing the map are seldom controlled by the cartographer, and usually the hues of the paper and the ink are chosen by others. Thus, any attempt to control these and similar variables in testing for the "best" value scale would not satisfy the day-by-day requirements of map use. The following tests are predicated upon the inability to control these conditions, for if a satisfactory value scale cannot be found that is applicable under varying conditions, it would have very little use in small scale mapping.

It must also be recognized that the testing is designed to determine which of five value scales is most practical for use on maps symbolized with self-adhesive shadings. No attempt is made to prove or disprove the theoretical bases of the various value scales, for a value scale adequate for this type of use might not function in other applications or even on maps symbolized with other media.

Graded series of tones are used in two different map situations: in an ordered series, as on isometric or isoplethic maps, and in an unordered series, as on chlorophethic or dasymetric maps. When the shadings are used in ordered series, the major objective is to represent even steps in visual impression. These even steps are associated with the percentage of inked area of each pattern; white representing "none or an empty area" and black representing "the most or a full area." The gray tones are associated

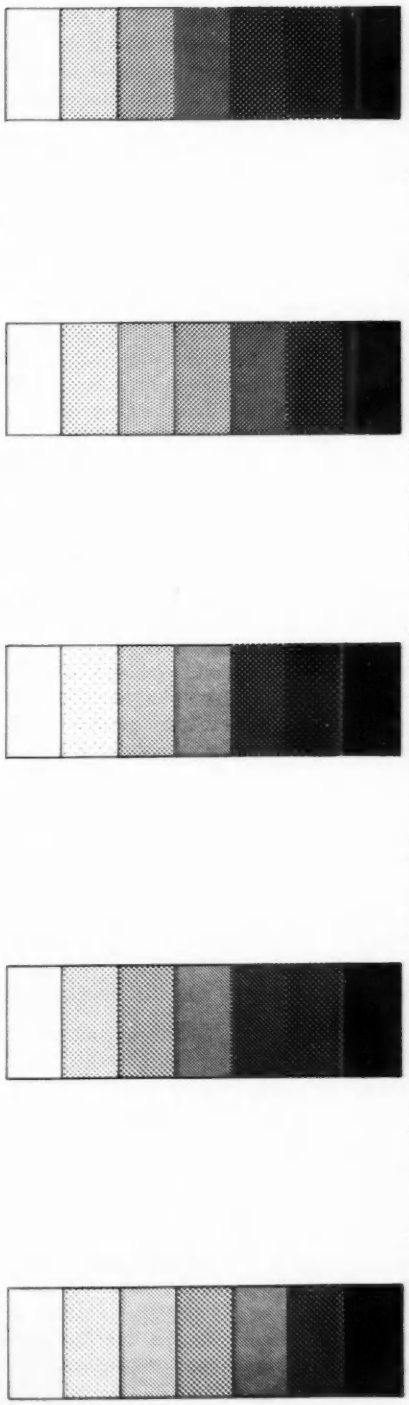


Fig. 3. A sample pre-test plate presenting five columns which vary only in the shadings used. Similar plates were used in the pre-test to present the same shadings on isometric maps, dasymetric maps, and three-dimensional diagrams.

with "more" than white but "less" than black. Thus in an ordered series the patterns always occur in a sequence and the problem is one of presenting equal visual steps in the gray spectrum.

While the impression of "empty" or "full" pertains when shadings are used in an unordered series, the major problem is that of relating shadings on the map that do not occur in sequence with a spectrum in the legend. Here there is need to associate the same intellectual value with a given visual value, even though the shadings surrounding one area are completely different from those surrounding another area. Obviously, patterns in such a series must be easily differentiated visually, so that the legend can be entered accurately.

The ability to differentiate tones in a graded series on a black and white map is directly related to the degree of contrast between the tones. As the number of tones in a series increases, the degree of contrast between tones decreases. In a series of three or four tones, contrast is easily achieved, but if more than six or seven gray tones are used, differentiation becomes difficult. Thus in testing value scales, the number of tones used must vary from relatively few to at least eight or nine, so that the threshold of differentiation can be determined. Any test for a practical value scale must therefore incorporate maps using area shadings in both isometric and dasymetric situations. Furthermore, a practical test should also have varying combinations of shadings, so that very dark shadings will dominate some maps, while other arrangements emphasize the middle grays and lighter shadings.

SELECTING SHADINGS FOR THE TEST PLATES

The shadings used on the test plates were selected by a process of elimination. First, irregular and line pattern styles were omitted because the preference tests seemed to indicate that the average map reader prefers dot patterns when shadings are used in graded series. Second, only those dot patterns which would reproduce adequately under average printing conditions were considered. The preference tests also indicated that fine-textured patterns are preferred over those of coarser texture and so the final step in the process of elimination was to select the remaining pattern that had the finest texture for each pattern value (percent of area inked).

Unfortunately, it is impossible to obtain a series of patterns of uniform texture throughout the complete value scale. Textural differences no doubt influenced the test results, but this variable has been eliminated so far as is possible because the finest textures available were used. To discard the test results on this basis, would mean that the use of self-adhesive shadings on maps must also be eliminated. At the present time it is highly unlikely that self-adhesive shadings can be replaced by a superior technique.

MEASUREMENT OF PERCENT OF INKED AREA

The manufacturers of shading media give the percent of inked area for some of the shadings listed in their catalogues, but in many cases these values were found to be gross approximations. The given percent of area inked was in error by as much as 15 percent in extreme cases and both positive and negative errors were obtained. The variability of these values led to attempts to ascertain more accurate values for the percent of inked area for nearly all available dot styles of self-adhesive shadings.

Measurements were taken with a shop microscope; determining dot diameter and dot spacing in thousandths of an inch. A random sampling of 20 such measurements was obtained for each shading. These measurements were compared with similar measurements taken on a second and third sample of some of the shadings. The average dot diameter and dot spacing was then used to calculate percentage of area inked.

These measurement procedures brought to light certain characteristics of self-adhesive shadings which were of concern in developing the test plates. There may be considerable variation in dot size and, therefore inked area, within a given sheet. In fact, the variation within sheets was often greater than variations between sheets of the same shading. Variations, both within and between sheets, pointed toward the need for more samples, but this did not prove feasible because there are no markings on the sheets to indicate edition or time of printing. Measurements of numerous sheets obtained in the same shipment and assumed to have been printed in order showed very little variation in inked area. Sheets printed with the same plate but at different times might have

considerable variation, since the amount of pressure on the presses and the amount of ink applied to the plate are difficult to control. In any case, the needs of practical accuracy seem to have been met since sheet-to-sheet variation averages less than 2 percent with an extreme variation of 4 percent.

The microscopic measurements for each pattern were checked against those made with a reflecting densitometer. One densitometer reading was from the original shading media, a second from a photographic positive, and a third from a printed copy of each shading pattern. The patterns used have increasing percentage of inked area in all of these measures.

The preparation of a testing instrument to determine which of the five curves of the gray spectrum is best for cartographic use is complicated by the large number of variations in which shadings are used on maps and graphs. Some common variations are in the number or arrangement of patterns (isarithmic or dasymetric) and in the proportion of the map within the dark or light ends of the spectrum. A test of all of these variables would necessitate over one hundred plates. Therefore, a pre-test was designed in an attempt to limit the number of variables. In this pre-test, the number of patterns used per illustration was held constant at seven, which enabled a satisfactory range of the other variables to be included in a test of 17 plates. Each plate in the pre-test was composed of five identical diagrams or maps which varied only in the shadings used (see Fig. 3). The patterns were the same from plate to plate, but the position of each curve on the plate was randomized. One-half of the plates were presented to the respondents in a learning order,[16] and the other half in a random order so that the effects of fatigue could be checked. The pre-test was further divided so that one-half of the respondents answered the question: "Which illustration has shadings that appear to grade in the most even steps from white to black?" The other half answered the question: "Which illustration has a set of shadings in which each pattern can be easily distinguished from all other patterns?" The first question is essential for determining the curve that most closely fits the isarithmic map situation. If the answers to both questions were identical, then the same curve should work equally well in either situation.

The pre-test was administered to 226 college students at the University of Kansas. One-half of the students answered the "graded series question" and the other half the "differentiation" question. Since the test was composed of 17 plates there were 1,921 responses to each question or a total of 3,842 responses. A chi square analysis of the significant differences in the frequencies of choice for each question was applied to the responses obtained (see Tables 3 and 4).

This analysis of pre-test results led to significant changes in plans for the major test. The Straight-Line curve was selected in only 173 of 3,842 responses (less than 5 percent) and was therefore eliminated from further testing. The answers on the random series of plates were not significantly different from those on the learning series of plates, indicating that fatigue was not a factor in the pre-test. As a result the larger test was administered in the learning order, since much less time was required in the preparation of the test booklets.

A great majority of the respondents selected the Williams or the Empirical curve when answering the "graded series" question (Table 3), and similarly, a great majority of respondents selected the A.C.I.C. or the Williams curve when answering the "differentiation" question. These substantial differences in responses to the two questions could mean that isoline and dasymetric maps pose different visual probelms or that map readers were extremely conscious of the difference in the wording of the two questions. Comparisons of chi squares in Table 3 show that the respondents found it much more difficult to select curves for the dasymetric maps than for the isarithmic maps when answering the "graded series" question. A similar comparison in Table 4 shows that the respondents found it easier to select curves for dasymetric maps when answering the "differentiation" question. We take this to mean that the two types of maps present different visual problems. This conclusion led to the omission of dasymetric maps on the final test, since the original intent was to test self-adhesive shadings in a graded series.

[16] The learning order tests presented the illustrations in order of complexity of number and type of illustration. For example, maps with four patterns preceded maps with five patterns, and isometric maps preceded dasymetric maps.

TABLE 3.—DIFFERENTIATION QUESTION

		Number of patterns	Chi Sq.	St. Line	Stevens	A.C.I.C.	Wms.	Empirical	Significant*
Columns	Spectral Column	4	151.289	5	4	1	2	3	yes
	Spectral Column Reversal	40	86.481	5	4	1	2	3	yes
3D Diagrams	Straight Slope	25	137.362	5	4	1	2	3	yes
	Concave Slope	27	79.254	5	4	1	2	3	yes
	Convex Slope	26	106.954	5	4	1	2	3	yes
	S-Slope	28	94.158	5	4	1	3	2	yes
Isometric Maps	Simple	12	79.874	4	5	2	1	3	yes
	Simple Reversal	120	89.962	4	5	1	1	3	yes
	Even	29	45.095	5	3	1	2	4	yes
	Gray	31	96.033	5	3	1	2	4	yes
	White	30	67.661	5	3	2	1	4	yes
	Black	32	46.953	5	3	2	1	4	yes
Dasymetric Maps	Complex	20	78.989	5	4	2	1	3	yes
	Complex Reversal	200	102.175	5	3	2	1	3	yes
	Squares	33	147.927	5	4	1	3	2	yes
	Generalized	34	48.812	4	5	2	1	3	yes
	Light Shades	35	93.533	5	3	2	1	3	yes

* The least highly significant value of chi square with 4 degrees of freedom, where $P = .001$ is 18.465.

THE MAJOR TEST

The major test was composed of two main groups of illustrations both commonly used in map situations: isarithmic maps and spectral columns. Each of these types was presented to the respondents in combinations of 4, 5, 6, 7, 8, 9, 10, and 11 patterns per illustration.

In addition, 4 three-dimensional diagrams having straight, concave, convex, and S-slopes were presented. Four isarithmic maps with 7 patterns but with varying proportions of white, gray, and black were also used. The seven-pattern isarithmic map and the seven-pattern spectral column in the first groups were presented a second time but turned upside down to see whether this positioning would influence responses.

Each test plate was composed of four illustrations identical except for shadings. One illustration on each page was shaded using the

TABLE 4.—GRADED SERIES QUESTION

		Number of patterns	Chi Sq.	St. Line	Stevens	A.C.I.C.	Wms.	Empirical	Significant*
Columns	Spectral Column	4	53.681	5	4	2	1	2	yes
	Spectral Column Reversal	40	45.715	5	3	4	1	2	yes
3D Diagram	Straight Slope	25	74.652	5	4	3	2	1	yes
	Concave Slope	27	40.582	5	3	4	1	2	yes
	Convex Slope	26	78.712	5	4	3	2	1	yes
	S-Slope	28	62.794	5	4	3	2	1	yes
Isometric Maps	Simple	12	64.652	3	4	5	1	2	yes
	Simple Reversal	120	43.534	4	5	3	2	1	yes
	Even	29	60.758	4	3	5	2	1	yes
	Gray	31	66.422	5	3	2	1	3	yes
	White	30	52.997	5	3	4	1	2	yes
	Black	32	51.289	3	3	5	1	2	yes
Dasymetric Maps	Complex	20	10.140	5	1	4	2	3	yes
	Complex Reversal	200	11.212	5	4	1	2	3	yes
	Square	33	40.408	5	4	3	2	1	yes
	Generalized	34	32.640	5	4	2	3	1	yes
	Light Shades	35	6.790	5	4	3	1	2	no

* The least significant value of chi square with 4 degrees of freedom where $P = .05$ is 9.488.

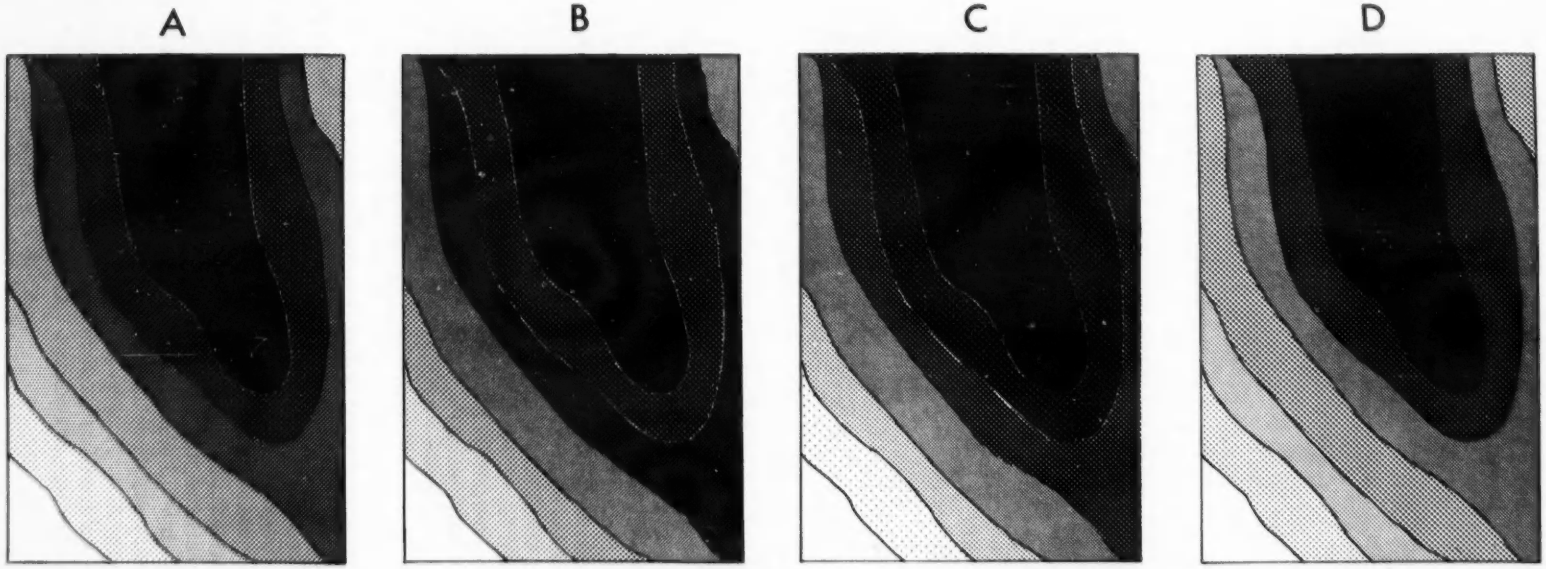


FIG. 4. A sample plate from the major test. In this test, plates, isometric maps, and spectral columns were the only types of figures presented.

TABLE 5.—TOTAL GROUP

		Number of patterns	Chi square	Wms.	Emp.	A.C.I.C.	Stevens	Signifi-cant*
		4	276.011	3	1	2	4	yes
		5	92.143	1	2	4	3	yes
		6	12.905	4	1	3	2	yes
Columns		7	213.890	1	2	4	3	yes
		8	43.882	1	4	3	2	yes
		9	73.350	2	1	4	2	yes
		10	229.113	3	1	2	4	yes
		11	117.232	4	1	3	2	yes
	Upside down	7	8.098	1	3	4	2	yes
	Straight	7	208.513	2	1	3	4	yes
3D	Concave	7	153.610	1	2	3	4	yes
Diagrams	Convex	7	236.157	1	2	3	4	yes
	S-Slope	7	162.743	1	2	4	3	yes
		4	224.479	3	1	2	4	yes
		5	82.856	1	3	4	2	yes
		6	29.751	1	3	4	2	yes
Isometric		7	193.592	1	2	3	4	yes
Maps		8	129.616	2	1	3	4	yes
		9	97.551	1	3	2	3	yes
		10	186.212	2	1	3	4	yes
		11	2.346	1	3	2	3	no
	Upside down	7	157.515	1	2	3	4	yes
	Even	7	224.283	1	2	4	3	yes
	Gray	7	170.646	1	3	2	4	yes
	White	7	75.541	1	2	3	4	yes
	Black	7	205.618	1	4	2	3	yes

* The least significant value of chi square with 3 degrees of freedom where $P = .05$ is 7.815.

A.C.I.C., Williams, Stevens, and Empirical curves of the gray spectrum. The position of the four curves was varied from plate to plate in a random manner. Printed instructions were issued as part of each test booklet, so that standard directions would be followed by all respondents. The last statement in these instructions was "Draw a circle around the letter above the illustration which appears to have visually even steps from black to white" (see Fig. 4).

The test was administered to 610 persons in 9 different universities in widely different sections of the country. The test group included persons ranging in age from 16 to more than 60, and students at all academic levels with a great variety of interests and map experience. Thus the results incorporate 15,860 responses or 610 responses on each of the 26 plates. Again a chi square analysis was made and the results are shown in Table 5.

No significant statistical differences between the responses of the various age, sex, experience, or interest groups were found. In fact, any differences based upon map experience show that the less experienced group was more consistent and discriminating than the experienced group (cf. Tables 5 and 6).

The Williams curve was selected most frequently by the respondents—first in 17 of the 26 plates. The Empirical curve was selected second most frequently—in 9 of the 26 plates. The A.C.I.C. and Stevens curves were not selected as first and only infrequently as second choice. When only maps were considered Williams' curve was selected as best in a more impressive ratio—10 out of 13 times. These results seem to bear out those from the pre-test, since the frequency of choice among the curves was similar.

The eccentric results shown in the responses to 4, 6, 8, 10, and 11 pattern columns and 4 pattern isometric maps are, in part, explained by poor printing. Smeared copies of these pages were inadvertently incorporated into some test booklets, but the exact number and extent of

TABLE 6.—EXPERIENCED GROUP

		Number of patterns	Chi square	Wms.	Emp.	A.C.I.C.	Stevens	Significant*
		4	61.288	3	1	2	4	yes
		5	17.460	3	1	4	2	yes
		6	17.791	1	1	3	4	yes
		7	62.862	1	2	3	4	yes
Columns		8	9.733	3	4	2	1	yes
		9	15.887	3	1	4	2	yes
		10	51.296	2	1	3	4	yes
		11	50.390	4	1	3	2	yes
	Upside down	7	10.964	2	3	4	1	yes
	Straight	7	72.707	2	1	3	4	yes
3D	Concave	7	49.597	1	2	4	3	yes
Diagrams	Convex	7	68.493	1	2	4	3	yes
	S-Slope	7	75.306	1	2	4	3	yes
		4	72.859	4	1	3	2	yes
		5	27.100	2	3	4	1	yes
		6	10.348	1	2	4	3	yes
Isometric		7	41.584	1	2	3	4	yes
Maps		8	36.688	3	1	2	1	yes
		9	39.120	1	2	3	4	yes
		10	55.376	3	1	2	4	yes
		11	7.033	2	1	4	2	no
	Upside down	7	26.963					
	Even	7	39.120	1	2	4	3	yes
	Gray	7	57.118	1	3	2	4	yes
	White	7	43.374	1	2	4	3	yes
	Black	7	75.989	1	2	3	4	yes

* The least significant value of chi square with 3 degrees of freedom where $P = .05$ is 7.815.

smeared copies is not known. There is also the problem of texture and its influence on the test results, for some pattern series had greater textural differences than others. Had it been possible to eliminate these printing and textural differences the test results would probably have been more consistent.

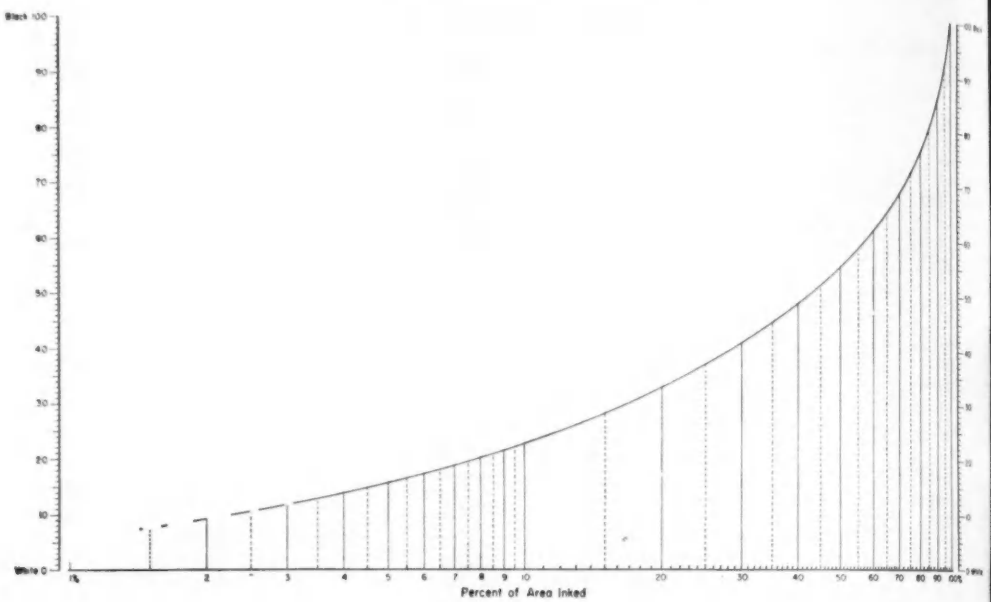
Very little can be concluded about the threshold of differentiation from the test. The responses on the 11-pattern isarithmic map were not significant but those on the 11-pattern spectral column were highly significant (see Table 5). This is surprising since there is general consensus among cartographers that the use of more than seven shadings is undesirable. It is certain that contrast between patterns decreases as the number of patterns used increases, and until further testing can be done it would seem unwise to use more than seven shadings.

The tests discussed here have been used to compare five different curves of the gray spectrum in an empirical manner with the stated objective of determining which curve best suits the needs of the cartographer using self-adhesive shading media. These results neither prove nor disprove the correctness of the psychophysical properties of the curves when used for other purposes or with other visual media. The tests do prove, however, that isarithmic maps constructed with patterns selected according to Williams' curve will more closely satisfy the visual requirements of map readers than patterns selected by the other systems.

PRACTICAL APPLICATION

To use the findings of this study a cartographer needs a graph of Williams' curve of the gray spectrum (Fig. 5) and data regarding the inked area and texture of commercial shading media. Data for a selected group of shadings are given in the shading pattern reference chart (Fig. 6). Application of these data is illustrated in the following example:

Assume that a cartographer wishes to use shadings to differentiate categories of (1) less



Curve of the grey spectrum.

FIG. 5. Williams' curve of the grey spectrum. The difference in the appearance of this curve and that shown in Fig. 2F is due to the fact that Williams plotted his horizontal axis on a logarithmic scale, whereas we have used an arithmetic scale on both axes.

This graph should be used in conjunction with the shading-pattern reference chart (Fig. 6). To use it, first enter the vertical axis of this graph at the desired percent of darkness and draw a horizontal line to the curve. Then follow a vertical line down to obtain the proper percent of area inked. Finally, enter the shading pattern reference chart with this figure and obtain the pattern number that should be used to give the desired degree of darkness.

than ten, (2) ten to twenty, (3) twenty to thirty, (4) thirty to forty, and (5) more than forty inches of precipitation. In this case, the first category is arbitrarily assigned white and the fifth category is arbitrarily assigned black, in a five-step gray spectrum. The second, third, and fourth categories will be shades of gray to be determined through the use of Figures 5 and 6. Equal visual steps in percent of blackness would be 0 percent (white), 25 percent (light gray), 50 percent (gray), 75 percent (dark gray), and 100 percent (black).

The next steps entail entering of the vertical axis of Williams' curve with these values, drawing a horizontal line to the curve, dropping down to the horizontal scale labeled "percent of area inked," and obtaining the values of 0, 12, 43, 79, and 100. These procedures are represented in Figure 2F, although the graph of Williams' curve in that figure is drawn on an arithmetic rather than a logarithmic base.

The final steps entail entering of column 1 of the shading pattern reference chart with the percent of area inked values (0, 12, 43, 79, and 100) and obtaining pattern numbers in column 5 and the name of the manufacturer in column 6 (4006 A, 40 Z, and 31w C). These patterns are identical to those shown in the spectrum under Figure 2F.

SUMMARY

We have presented data showing that Williams' curve of the gray spectrum is best suited to the needs of the cartographer constructing isometric maps. This study also illustrates the need for additional research into the use of shadings on dasymetric maps, the effect of pattern texture on map reading, and the need to determine the threshold of differentiation in spectral arrangements of self-adhesive shadings. An illustration of the need for research of this kind is given in Figure 6, where some pat-

SHADING PATTERN REFERENCE CHART
Showing (1) Per Cent of Area Inked, (2) Densitometer Rating, (3) Pattern Sample, (4) Screen Texture, (5) Pattern Number, (6) Manufacturer.

SHADING PATTERN REFERENCE CHART

Showing (1) Per Cent of Area Inked, (2) Densitometer Rating, (3) Pattern Sample, (4) Screen Texture, (5) Pattern Number, (6) Manufacturer.

1	2	3	4	5	6
0	.11				
3	.13		16	3	Z
10	.18		28	30	C
13	.19		29	Z	Z
13	.19		30	4006	A
15	.22		32	4011	A
16	.22		32	75	C
18	.24		38	95A	Z
21	.24		32	51B	Z
23	.24		36	89B	Z
24	.25		32	95B	Z
25	.25		36	71	C
26	.27		40	E	Z
27	.27		28	4002	A
29	.30		30	4008	A
32	.31		36	76	C
34	.32		34	4013	A
35	.33		28	9	Z
39	.35		40	12	C
41	.41		28	4004	A
43	.41		36	40	Z
45	.45		32	4014	A
45	.46		30	113	C
49	.47		28	34	C
50	.48		40	14w	C
52	.55		40	13	C
55	.65		36	100	C
56	.65		32	4014w	A
63	.72		36	227	Z
63	.74		40	12w	C
67	.78		30	102	C
68	.80		30	4008w	A
71	.82		36	L	Z
74	.86		28	4003w	A
82	.88		28	31w	C
84	.97		29	Zw	Z
88	1.00		26	83w	C
92	1.12		18	84w	C
100	1.40				

FIG. 6. Shaded pattern reference chart. The patterns in this reference chart are presented in order according to the percent of the area covered with ink. Measurements of the area inked were obtained with a microscope and a reflecting densitometer. Even though these instruments provide measurements that are completely in agreement, some patterns appear to be out of order.

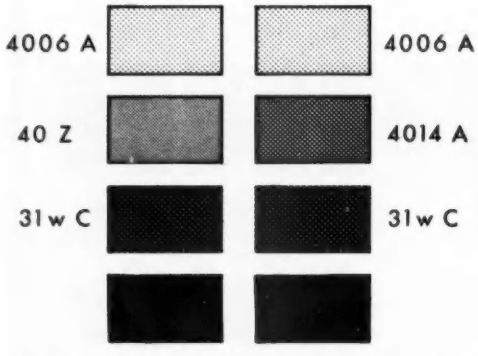


FIG. 7. These two columns illustrate the importance of texture in a graded series of patterns. When pattern 40 Z in the left column is replaced by pattern 4014 A, as in the right column, a more uniform gradation results.

terns appear to be out of order in that they appear to be lighter or darker than patterns on either side. This apparent misalignment is evidently a function of texture since both microscopic and reflectance measurements agree with the order of presentation (columns 1 and 2). Unfortunately, patterns with uniform texture are not available, so that these patterns must suffice for the time being, but one may hope that manufacturers will remedy this deficiency in the near future.

Since texture is apparently of great visual importance, it might prove desirable if patterns slightly darker or lighter than those recommended were selected and if uniform textures could be obtained throughout a given series of shadings. The texture of each pattern in the reference chart is given in the fourth column of Figure 6, and an example of this shift can be seen in Figure 7, where the left spectrum is selected directly from the curve and the right spectrum is altered by substituting pattern 4014 A for 40 Z. Some duplicate values of different textures are given in the chart, but when none is available the decision whether to use uniform texture or exact tones must be based upon the preferences of the individual mapmaker.

PROGRESS IN LAND CONSOLIDATION IN SPAIN

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IN a previous study the writer examined in detail the problems of *minifundismo* and property fragmentation in Spain, and the structure and reform program of the Servicio de Concentración Parcelaria.[1] Even utilizing the 1945 figures of the Servicio de Catastro de Rústica, which at that time had surveyed little more than half of the 120 million acres of the country, it could be vividly shown that central and northern Spain (together with northwest France, southwest Germany, and southwest Switzerland) presented some of the most severe cases in Europe of excessive subdivision of landholdings.[2]

Especially since 1954 survey work has proceeded at a faster rate, reaching a total taxable area of 103 million acres by December 31, 1959. The latest figures permit a reanalysis of the extent of property fragmentation in Spain,[3] while at the same time the June 1960 report of the S.C.P. reveals the notable progress being made in solving the problem.[4]

THE ANOMALOUS DISTRIBUTION OF RURAL PROPERTY

The 1959 survey figures confirm that very large and very small properties predominate in Spain, at the expense of medium-sized holdings. Small properties (less than 25 acres) occupy 39 percent of the area surveyed and large holdings (over 240 acres) occupy a further 32 percent. The origins of this uneven pattern may be summarized as follows:

(1) The *latifundios* have their origins in the acquisition by private interests of extensive common grazing and municipal pastures; in the privileges and monopolies of the pastoral brotherhood of the Mesta; in the *mayorazgos*[5]; and in the legislation of Mendizábal, Minister of Finance 1833–40, which was directed at the breaking up and sale of Church properties.

(2) The principal cause of the *minifundios* has been the Civil Code, which does nothing to impede and even encourages the subdivision of landholdings by its provisions for equal inheritance and the compulsory sharing of patrimonies. To this must be added the influence of the relief of the Peninsula (the cultivation of tiny patches of soil blessed with some humidity; terrace and mountain-side cultivation; the tillage of small areas of public pasture—all implying the dispersion of holdings) and the pressure of population on the land (48 percent of the working population is engaged in agriculture).

The most outstanding fact emphasized by the 1959 survey data is the enormous extent to which tiny holdings predominate in Spain, above all in the center and north. The latest figures reveal an atomization and fragmentation of property far greater than could be provisionally deduced from the 1945 data (see Table 1).

Out of 54 million holdings occupying the 103 million acres surveyed, 48.71 million holdings (90.13 percent of the total) are less than 2½ acres and 52.95 million (97.98 percent) are less than 12 acres. The worst provinces in this regard are Orense (where 99.3 percent of all holdings are only 2½ acres or less), followed by Pontevedra (99.1 percent), León (98.8 percent), Soria (97.2 percent), Burgos (97.0 percent), Guadalajara (96.6 percent), Coruña (96.3 percent), Lugo (95.9 percent), and Zamora (95.7 percent).

Of the 6 million farmers occupying the area surveyed, 2 million possess less than 1.2 acres, 3.12 million possess less than 2½ acres, and 5 million (82 percent of the total) have less than

[1] John Naylon, "Land Consolidation in Spain," *Annals*, Association of American Geographers, Vol. 49 (1959), pp. 361–373.

[2] For a summary of the European situation see "Tercera Reunión del Grupo de Trabajo de la F.A.O. sobre Concentración Parcelaria," *Revista de Estudios Agro-Sociales*, No. 27 (Madrid, 1959), pp. 175–186.

[3] See G. García-Badell y Abadía, "La Distribución de la Propriedad Agrícola de España en las diferentes categorías de fincas," *Revista de Estudios Agro-Sociales*, No. 30 (Madrid, 1960), pp. 7–32.

[4] *Resumen de la situación de los trabajos de concentración en las distintas zonas, correspondiente al 30 de junio de 1960* (Madrid: Ministerio de Agricultura, Servicio de Concentración Parcelaria, 1960).

[5] The *mayorazgo*, an institution abolished in 1820, had as its object the perpetuation of property intact in one family by prohibiting its sale or division among heirs.

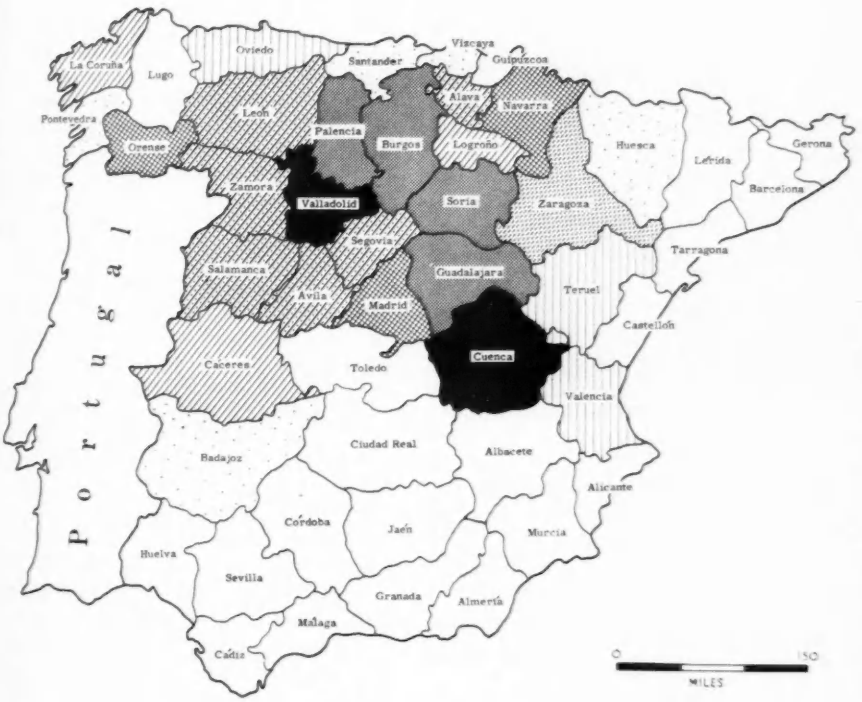
TABLE 1.—DISTRIBUTION OF RURAL PROPERTY IN SPAIN, 1959

Provinces	Number of districts	Area (thousands of acres)	Number of parcels	Number of proprietors	Number of parcels per proprietor	Average area per parcel (acres)	Average area per proprietor (acres)
Albacete	86	3,527	549,754	109,598	5.01	6.41	32.18
Alicante	140	1,333	435,485	150,276	2.90	3.06	8.88
Almería	103	2,061	410,746	101,469	4.05	4.94	20.32
Avila	269	1,892	975,375	120,068	8.12	1.94	15.76
Badajoz	162	5,108	542,223	137,891	3.98	9.42	37.04
Baleares	65	1,350	227,402	97,748	2.32	5.94	13.82
Barcelona	309	1,665	212,065	68,876	3.07	7.85	24.17
Burgos	499	3,190	3,222,456	219,781	14.66	0.99	14.51
Cáceres	224	4,622	1,026,812	136,153	7.54	4.50	33.95
Cádiz	42	1,737	86,753	26,000	3.33	20.03	66.83
Castellón	141	1,558	743,775	186,205	3.99	2.09	8.37
Ciudad Real	98	4,621	692,736	135,545	5.11	6.67	34.09
Córdoba	75	3,227	271,046	81,680	3.31	11.91	39.52
Coruña	94	1,803	4,988,540	357,445	13.95	0.36	5.04
Cuenca	290	3,963	2,383,680	165,113	14.43	1.66	24.00
Gerona	78	466	59,121	21,054	2.80	7.89	22.15
Granada	198	2,877	471,669	127,922	3.68	6.10	23.70
Guadalajara	408	2,847	2,443,183	131,205	18.53	1.16	21.70
Guipuzcoa	88	393	97,183	22,192	4.37	4.15	18.17
Huelva	78	2,365	201,007	58,992	3.40	11.77	40.10
Huesca	187	1,772	388,318	49,607	7.82	4.56	35.74
Jaén	101	3,148	471,602	145,749	3.23	6.68	21.60
Las Palmas	13	140	85,495	28,173	3.34	1.64	4.98
León	165	2,353	2,652,469	187,068	14.18	0.85	12.58
Lérida	156	1,002	254,098	61,450	4.13	3.94	16.32
Logroño	183	1,170	962,180	110,104	8.73	1.21	10.63
Lugo	69	2,284	3,667,250	204,651	17.91	0.62	11.16
Madrid	195	1,817	563,120	84,460	6.72	3.20	21.44
Málaga	100	1,719	362,975	84,787	4.28	4.74	20.28
Murcia	42	2,650	567,913	111,232	5.10	4.67	23.59
Orense	74	1,364	3,726,747	260,371	14.31	0.37	5.24
Oviedo	42	986	1,285,098	119,579	10.74	0.77	8.25
Palencia	236	1,738	1,195,815	97,550	12.20	1.45	17.82
Pontevedra	35	565	2,087,938	170,732	12.24	0.27	3.31
Salamanca	386	2,888	1,261,265	142,405	8.85	2.29	20.28
S.C. de Tenerife	54	788	535,500	115,224	4.64	1.47	6.84
Santander	102	1,203	731,626	95,998	7.62	1.64	12.53
Segovia	279	1,493	1,503,198	140,921	10.66	0.99	10.60
Sevilla	102	3,287	163,773	57,893	2.82	20.07	56.78
Soria	347	2,414	2,733,370	104,099	26.25	0.88	23.20
Tarragona	180	1,481	345,512	119,549	2.96	4.18	12.39
Teruel	143	1,810	742,056	78,183	9.49	2.44	23.15
Toledo	206	3,234	786,934	161,024	4.88	4.11	20.09
Valencia	264	2,504	1,214,009	324,175	3.74	2.06	7.73
Valladolid	236	1,908	939,639	100,543	9.34	2.03	18.98
Vizcaya	114	511	383,216	31,423	12.19	1.33	16.27
Zamora	308	2,456	3,077,545	185,420	16.59	0.80	13.25
Zaragoza	305	3,907	1,289,210	162,044	8.01	3.01	24.11
Total	8,071	103,360	54,041,885	5,989,637	9.02	1.91	17.25

Based on data provided by the Servicio de Catastro de Rústica de la Dirección General de Impuestos sobre la Renta.

12 acres. The average area per farmer in the country as a whole is 17.25 acres; but this average includes regions of *latifundismo* such as Cádiz, with 66.83 acres corresponding to each farmer. In Pontevedra, on the other hand, the average farmer possesses only 3.31 acres (at the other end of the scale there are 394 landowners in Spain with properties exceeding 12,000 acres). What these figures mean from the economic aspect may be judged from the fact that 82 percent of Spanish farmers possess holdings with a taxable value of only 4,000 pesetas per year (at the present rate of exchange approximately 66 dollars).

PROVINCES
INVOLVED IN THE
LAND CONSOLIDATION PROGRAM
JUNE 1960



IN ACRES

Over 400,000 | 100-200,000 | 25-50,000 | 10-15,000
200-400,000 | 50-100,000 | 13-25,000 | Under 10,000

SOURCE: RESUMEN DE LA SITUACION DE LOS TRABAJOS DE CONCENTRACION EN LAS DISTINTAS ZONAS, CORRESPONDIENTE AL 30 DE JUNIO DE 1960. MADRID: MINISTERIO DE AGRICULTURA, SERVICIO DE CONCENTRACION PARCELARIA, 1960

The gravest aspect of *minifundismo* in Spain is that not only are properties very small in total area but that they are further fragmented into tiny parcels scattered at considerable distances from each other. The property of each farmer in the country as a whole is split up into 9 parcels; but on the northern meseta and in Galicia fragmentation is at its worst; in Soria, for instance, the average farmer has his property divided into 26 sections. The size of these parcels is often minute; 98 percent of all parcels of land in Spain are less than 2½ acres, with a national average (including areas characterized by large estates, such as Sevilla and Cádiz) of 1.91 acres; but in the provincial picture, in Pontevedra for instance, the average size of a parcel drops to a mere 0.27 acres.

PROGRESS IN LAND CONSOLIDATION

The small holding, just as much as the medium or large property, has an important economic and social function. If it is not to disappear or become unworkable, drastic measures are called for; but the solution to the problem of *minifundismo* is not likely to be found in breaking up the *latifundios*, on whose optimum functioning much of the Spanish economy depends. The large property should only be attacked when it is not being rationally worked. Before subdividing the *latifundios* as a solution to pressure on the land, other remedies should be sought, e.g., the extension of irrigation, which not only increases production but also permits the settlement of a larger rural population. Certainly the private capital at present invested in the transformation of the *latifundios* is insufficient; but here the answer would seem to be in state loans and tax exemptions rather than in expropriation.

The most promising solution to the pressing problems of *minifundismo* and fragmentation lies in reform from within the smallholding structure, i.e., in the consolidation program of the Servicio de Concentración Parcelaria. Up to June 30, 1960, from the foundation of the S.C.P. in 1952, 888 towns and villages, belonging to 738 zones with a total area of 3,092,484 acres, had petitioned its intervention in the reorganization of their landholding pattern. The provinces to which these districts belong are shown in Figure 1. By December 31, 1960, the program had expanded to include 989 towns and villages and 822 zones comprising 3,353,249 acres; of this total area 176,192 acres had been completely transformed.

The S.C.P. has 11 delegations working in 31 provinces. Most progress is being made on the dry-farming grainlands of the Meseta; in the province of Valladolid, where the pioneer work of consolidation was carried out, 444,948 acres are affected by the reform program, followed by Cuenca (431,074 acres), Palencia (384,397), Burgos (240,902), Soria (229,625), and Guadalajara (226,466). A beginning has been made in the Galician provinces of Orense, Pontevedra, and La Coruña, where both subdivision of property and the obstacles to reform are most serious; but in Galicia as a whole 894,290 acres are in need of consolidation, which has so far only been completed on 1,472 acres.

Although this program of direct state action is proceeding at a rate which reflects great credit on the S.C.P., millions of holdings and millions of acres remain to be reorganized. It is estimated that 40 percent of the cultivated area of Spain (some 19 million acres) needs consolidating. Within the period 1960–65 it is hoped to transform 1,812,750 acres, but with the means at present at its disposal the S.C.P. can only consolidate 241,700 acres per year as a maximum (compared with the annual rate in France, for instance, of 725,000 acres). Petitions for consolidation are coming in at the rate of, for example, 493,068 acres in 1960 alone.

One answer to the problem would be to extend the functions of the S.C.P. to the direction and guidance of private consolidation schemes, providing not only the benefits of experience but also financial aid to cover the costs of legal advice, property registration, the drawing up of projects, and actual technical work. Basically, there is a pressing need for new concrete and drastic legislation to halt the subdivision of property, which is still continuing.

VERNOR CLIFFORD FINCH, 1883–1959

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VERNOR Clifford Finch was one of the formerly small number of students who selected geography as a profession from the beginning of graduate work, as distinct from those of a former generation who had first been trained in other fields and then shifted into geography. During the period of his active career, 1911–51, geography was undergoing rapid expansion in the colleges and universities of the United States and the character of that development has been influenced in no small part by his research, his writings, his teaching, and his personality. The tribute which the dean of his college has expressed on behalf of the university community applies likewise to the Association of American Geographers: "he worked tirelessly to do everything he could to help the University on any occasion. He was a splendid person to whom we all owe a tremendous debt."

Vernor Clifford Finch was born on a farm near Tecumseh, Michigan, October 18, 1883. He was graduated from Kalamazoo College in June, 1908, and received the bachelor's degree also from the University of Chicago after studying there during the summer term of the same year. Following a year of high school teaching at Mt. Pleasant, Iowa, he returned to Chicago to do graduate work in geography during the next two years and in 1911 was appointed Assistant in geography at the University of Wisconsin. During the remainder of his career he was attached to the University of Wisconsin, becoming Instructor in 1912, Assistant Professor in 1916 (following attainment of the Ph.D. degree from Wisconsin during that year), Associate Professor in 1918, and Professor in 1927. When geography was separated from geology in 1928, he was named chairman of the new department and served in that position for 17 years until relieved at his urgent request in 1945. During the next six years he continued to carry his full share of departmental work, but in 1951 failing health forced him to retire from active teaching, and in 1954 he was named Emeritus Professor. Continued decline in health unfortunately prevented him from carrying out his plans for completion of studies in agricultural geography on which he had long been engaged and greatly limited his ability to enjoy the fruits of retirement. After a long illness, he died October 23, 1959.

During his forty years of service at Wisconsin he was on leave for two periods, first for a semester in 1915 to work in the United States Department of Agriculture with Dr. O. E. Baker in the production of the "Geography of the World's Agriculture," and for a year and a half during the First World War, to serve as special expert in the Commodity Section of the Division of Planning and Statistics of the United States Shipping Board, 1918–19. He also served as visiting professor in various summer sessions at Clark University, University of California at Los Angeles, University of Michigan, and Harvard University.

At about the time he graduated from Kalamazoo College, Vernor Finch became engaged to a classmate, Louise Lassfolk, and they were married four years later, in 1912. Their two sons have also entered teaching; John, in

mathematics at Beloit College, Thomas in physics at St. Lawrence University. He is survived by his wife, two sons, and two grandsons.

Among the leaders of American geography of the past generation, Vernor C. Finch was distinctive in the variety of ways in which he contributed to the development of the profession.

Two of his research publications have been widely recognized as landmarks in the development of American geography. The "Geography of the World's Agriculture," which he prepared in collaboration with O. E. Baker, was used for decades as a basic work in the study of agricultural geography; in addition it was long recognized as a model in geographic cartography in its use of the dot-map technique to portray distributions on a macroscopic scale. At the opposite end of the scale, his demonstration of the "fractional" method of representation of landscapes in the "Montfort study" brought to conclusion a long series of discussions and experiments by a number of American geographers; its definitive demonstration both of the disadvantages and advantages of the technique provided the basis on which later students could determine the feasibility of applying the method to the practical problems of regional planning.

The textbooks on which he collaborated, first with R. H. Whitbeck and later with G. T. Trewartha, were outstanding in college geography in organization and presentation of challenging material—much of it representing original research. Their wide use in geography did much to raise the level of college courses throughout the country and to establish respect for the subject in the minds of colleagues in other fields. Likewise influential and useful were the several series of wall maps of products and industries which he prepared during the period 1920 to 1930 for publication by Nystrom and Company.

As a teacher, Professor Finch devoted himself unsparingly to his students, whether in large elementary classes or in smaller advanced courses. He was at his best with mature students who could appreciate his well-organized lectures and his clear and logical exposition. His courses in Agricultural Geography and Anglo-America were models in content and organization which have been widely followed by former students now teaching in other institutions. It was especially in graduate research seminars and in the supervision of doctoral dissertations that full scope was found for his critical faculties and his high standards of scholarship. But in his relations with students, as well as with staff members and other colleagues, emphasis on scholarship was always combined with great personal consideration, sympathy, and genuine kindness. The fruit of these labors is to be observed in the respect and affection in which he was held by his former students and in the positions of distinction which many of them now occupy in the faculties of American universities.

Although conventional in manner, Finch was never satisfied, either in teaching or research, merely to continue along lines and methods learned in his graduate training. Rather he was deeply concerned that geography should have a sound methodological and scientific foundation and was constantly seeking for more effective concepts and methods of work. In the period of turmoil of the 1920's in American geography, originating in concern over the basic purpose of the subject, he was one of the first of his generation to revise his viewpoint and his writings in the light of concepts which have ultimately come to have general acceptance. His modest estimate of his own ability in philosophic thinking caused him generally to look to others to expound on the nature of geography, but nonetheless he made numerous useful contributions on specific questions in papers presented at meetings of the Association of American Geographers, and, when he felt his own position challenged, presented a vigorous and effective exposition in his presidential address of 1938 on "Geographic Science and Social Philosophy."

The value of his services as chairman of the Department of Geography at the University of Wisconsin from its inception in 1928 until 1945—and as senior advisor during the following years—is reflected in the increase in size and standing of the department in that period. At the same time, Professor Finch was known in the university as a wise advisor and useful citizen; with no desire to assert himself in administration, he was an able and devoted worker on committees to which he was assigned.

Finch was also concerned that geography

should contribute to the national service. Much of his research and teaching was directed toward making geography as useful as possible for society. In his own service in Washington during the First World War he was able to apply his special knowledge of the distribution of the world's agriculture to controversial and complex problems of control of commodity shipping. In the Second World War, when government agencies called for the services of his department members even before the entry of this country, he cheerfully accepted the extra burdens thus placed on him as department chairman to make it possible for them to take leave for such service.

The Association of American Geographers in particular is indebted to Vernor Finch for repeated services in a variety of capacities during the twenty-five years following his election to membership in 1920. During that period he served as an elected or appointed officer no less than 13 years, a record exceeded by not more than three other members in the history of the Association. He was treasurer from 1924 to 1928, vice-president in 1934, president in 1938, member of the council as past president during the next two years, and finally served as Editor of the *Annals* for the four years 1943–46.

While Finch himself was not motivated by desire for honors and was rather embarrassed by those he received, it is good to record that the academic profession recognized his accomplishments during his lifetime. In 1930, The American Geographical Society elected him to "Honorary Corresponding Membership." In 1933 he was given the honorary degree of Doctor of Science by his alma mater, Kalamazoo College. In 1938, as noted above, he was named president of this Association. In 1948 he was awarded the Helen Culver Gold Medal of the Geographical Society of Chicago "for distinguished contributions to Economic Geography." In 1950, "in recognition of outstanding service in the field of geographic education," he received the "Distinguished Service Award," the highest honor granted by the National Council of Geography Teachers. Following his retirement at Wisconsin, the department converted the office he had occupied so many years into the Finch Seminar Room to serve as a study place for graduate students and as a reminder of the spirit which continues to contribute to the *espirit de corps* of the department. Two years after his death, the University named one of the new professorships being established for research the Vernor C. Finch Research Professorship.

A modest and unassuming man, he was inclined to minimize his abilities and accomplishments. His former students and colleagues cherish his memory as a warm friend, a wise counselor, a dedicated teacher, and a scholar of integrity and unselfishness.

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In addition to the list of books and articles published, are the following: abstracts of papers read at annual meetings of this Association as published in the following volumes of the *Annals*, 7, 11, 15, 16, 17, 19, 24, 29; reviews in the *Journal of Geography*, Vol. 8, and in the *Geographical Review*, Vols. 16, 18, 22, 30, 31, 34; and the several series of wall maps, more than two score in all, published by Nystrom & Co., notably those showing products and industries for the United States and for the world.

ANNALS MAP SUPPLEMENT NUMBER TWO
THE FLOOR OF THE WORLD OCEAN

RICHARD EDES HARRISON

THE funds for the production of this map were provided by the Geography Branch, Office of Naval Research. Unfolded copies may be obtained from the Central Office, A.A.G., 1785 Massachusetts Ave., N.W., Washington 6, D.C. Prices, postpaid: single copy, 75¢; 2 to 99 copies, 45¢ each; over 100 copies, 30¢ each. 1,400 copies will be available for sale. It has been arranged that receipts for this and subsequent Map Supplements will be divided as follows: 25 percent to the Central Office and 75 percent to the Map Supplement Fund.

The Map Editor has accepted three more projects to be published as Map Supplements, but none of these can be scheduled until funds to cover publication costs are at hand or pledged. Bogdan Zaborski's very important ETHNO-LINGUISTIC MAP OF EURASIA, originally scheduled as Map Supplement Number Two, has been delayed because it has not been possible to raise the $5,000 required for this 15-page, 9-color map. The Map Editor found it difficult to raise the modest sum of $475 needed for Map Supplement Number One chiefly because not a single publisher in geography in Boston, New York, or Philadelphia responded to our appeal for funds. It is curious that, with one exception, all contributions came from the Chicago area. Members of this Association with contacts among Eastern Seaboard publishers, are urged to make every effort to explain to them the aims of this program and its need for support from those who will be its eventual beneficiaries. It should be emphasized that, once the program is well under way, it will be increasingly self-supporting as the maps have been priced with this end in view.

RICHARD EDES HARRISON
Map Editor

In accordance with commitments made last year, I will be engaged in field work in Pakistan, on a Fulbright Research grant, from Autumn 1961 until Spring 1962. Norton S. Ginsburg has consented to serve as Acting Editor during this period. Marvin W. Mikesell will continue to serve as Assistant Editor. Readers of the *Annals* should note also that a new Review Editor is listed on the inside covers of this issue. Jesse H. Wheeler, Jr. has accepted this assignment, succeeding Marion E. Marts.

ROBERT S. PLATT
Editor